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BACKGROUND DOCUMENT

CASE STUDIES ON GROUND-WATER AND SURFACE WATER CONTAMINATION FROM MUNICIPAL SOLID WASTE LANDFILLS

"CRITERIA FOR MUNICIPAL SOLID WASTE LANDFILLS"
(40 CFR PART 258)

SUBTITLE D OF RESOURCE CONSERVATION AND
RECOVERY ACT (RCRA)

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF SOLID WASTE

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1.0 EXECUTIVE SUMMARY

The purpose of this report is to identify and describe human health and environmental impacts (excluding impacts from subsurface gas migration) that have resulted from the operation of municipal solid waste landfills (MSWLFs) and, where possible, determine what role the design, operation, and location of the facility played in creating the problem. Numerous sources of information were reviewed to identify MSWLFs that have resulted in some type of adverse impact to ground water, surface water, or wildlife. These efforts resulted in identifying 163 MSWLFs for which adverse impacts had been documented. For 111 of these sites, sufficient information was available to identify how design, operation, and location of the facility contributed to the problem.

1.1 Ground-Water Impacts

Ground-water contamination was the most commonly reported problem associated with MSWLFs and was found at 146 sites. The severity of the contamination varied from simply elevated levels of various constituents in on-site ground water to the contamination of major aquifers and/or productive well fields. Thirty-five (35) facilities were documented to have adversely impacted private or community water supply systems. In 17 of these cases, alternative water supplies were necessary.

Various levels of corrective action were initiated in response to ground-water contamination. Site closure and improvements to the design or operating requirements of the unit were most common. Most actions were taken to prevent further contamination from occurring. In very few cases were measures taken to remove the contaminants from the ground water. Insufficient information was available to determine the effectiveness of the corrective actions taken.

1.2 Surface Water Impacts

Surface water contamination was reported to have occurred at 73 MSWLFs. Less information, however, was available on the severity of the contamination and their causes, although leachate seeps and contaminated run-off were frequently mentioned. In several cases, discharges of leachate to surface water were apparently deemed acceptable under the assumption that adverse impacts would be mitigated by dilution It could not be determined if these assumptions considered the potential for the accumulation of contaminants in sediments, flora, or fauna. The corrective actions most commonly applied to surface water contamination problems were regrading to improve drainage or the installation of run-on and run-off control systems. Again, insufficient information was available to determine the effectiveness of these measures.

1.3 Ecological Impacts

Little information was available documenting adverse impacts to wildlife or habitats from MSWLFs. The 13 cases that were identified, however, indicate that damages may be occurring that are not readily visible. Two (2) types of ecological damage were found: (1) catastrophic events, evidenced by fish kills or other damages to flora or fauna, that were a result of the direct discharge of leachate into a surface water,and (2) chronic long-term events, evidenced by subtle changes in the flora and fauna in the vicinity of the facility, that are the result of the slow introduction of contaminants into the environment and their accumulation in sediments or living organisms. The chronic long-term events are the least likely to be discovered and, yet, have the potential to do great harm.

1.4 Relationship of Design, Operation, and Location to Adverse Impacts

No one factor appeared to be the cause of the various ground-water and surface water problems found at MSWLFs. The MSWLFs at which problems were identified, however, did appear to have a common set of characteristics, that in combination contributed to the problem:

- lack of or inadequate means of controlling leachate generation and migration (e.g., final cover, run-on/run-off control systems, liners, leachate collection systems), and

- poor locational features (e.g., permeable soils, shallow ground water, wetlands) that further aggravated the lack of environmental controls by allowing rapid migration of the contaminants.

2.0 PURPOSE AND SCOPE

This report has two purposes: (1) to identify and describe human health and environmental impacts (not including impacts from subsurface gas migration which are addressed in other documents) that have resulted from the operation of municipal solid waste landfills (MSWLFs), and (2) to determine if a link exists between ground-water and surface water contamination problems at MSWLFs and the design, operation, or location of such facilities.

In order to meet these goals, numerous sources of information were reviewed to identify MSWLFs at which ground- or surface water contamination, or environmental damages had occurred. These sources included MSWLF case studies prepared by and for the Environmental Protection Agency (EPA), information obtained from a literature search of newspapers and journals, and information obtained from a telephone survey of select States that indicated that case studies were available in the 1984 State Subtitle D Program Questionnaire. All information sources are listed in the Section 7.0, References. Once a site had been identified as having caused some type of damage, the information on that site was further evaluated to determine:

- the severity of the damage,
- whether there was a potential relationship between the damage and the design, operation, or location of the MSWLF, and
- the type of corrective action, if any, that may have been implemented.

Section 3.0 of this report provides general information on the environmental contamination problems caused by MSWLF activities and discusses their significance. Section 3.0 also discusses existing Federal statutes and state policies, mechanisms of leachate generation and migration, and several reports and surveys depicting impacts to both ground-water and surface water environments.

Section 4.0 describes the human health and environmental impacts that have resulted from MSWLFs and, to the extent possible, the severity of these impacts. Section 5.0 describes the potential causal relationships between MSWLFs and their design, operation, or location. Section 6.0 summarizes, in tabular form, the information on the case studies used in this report.

3.0 BACKGROUND

3.1 General Information

Land disposal of wastes is an important element of solid waste management. Equally important is the ability to conduct landfill operations without adversely impacting ground water, surface water, or the environment. It is estimated that by the year 1990, a projected 295 to 341 million metric tons of municipal refuse will be produced annually in the United States. The disposition of this huge volume of waste material into MSWLFs increases the potential for adversely affecting human health and/or the environment One major factor in environmental protection at a landfill site is leachate control Leachate from solid waste disposal sites can be a significant source of ground-water and surface water contamination if not properly managed. The resulting impacts occur when water passing through refuse accumulates various contaminants and migrates into underlying ground waters, seriously degrading the water quality of the aquifer. These adverse impacts can have a serious economic problem when ground-water resources are lost indefinitely (18). Subsequently, hydrologically interconnected surface water bodies may also be affected (20).

In the 1977 Report to Congress (18) on waste disposal practices and their effects on ground water, data current at that time indicated that waste disposal facilities (including domestic septic systems) were releasing over 1700 billion gallons of contaminated liquid into the ground each year. This resulted in ground-water contamination on both a local and regional basis in all parts of the nation. The degree of contamination ranged from a slight degradation of the natural quality to the presence of toxic concentrations of heavy metals and organic compounds. With the increasing demands on land and water resources, the protection of these resources from leachate impacts posed by MSWLFs has become a vital Agency program objective.

3.1.1 Existing Federal Programs

The primary Federal program regulating MSWLFs is the Resource Conservation and Recovery Act (RCRA) of 1976, administered by EPA. Other Federal programs administered by EP[illegible]ress many of the potential sources of ground-water contamination, although they do not provide comprehensive protection of ground-water resources and hydrologically connected surface water resources from impacts posed by MSWLFs. These programs include the Federal Water Pollution Control Act Amendments (FWPCAA) of 1972, the Safe Drinking Water Act (SDWA) of 1974, and to lesser degrees the Solid Waste Disposal Act of 1965 and the National Environmental Protection Act (NEPA) of 1969.

The FWPCAA provides for State and area-wide treatment, management, and planning functions that include identifying and controlling pollution from mine runoff, from the disposal of residual waste, and from the disposal of pollutants on land or in subsurface excavations. However, the FWPCAA does not address the discharge of contaminants to ground water from surface impoundments, land disposal of solid wastes, septic systems or most wells (18).

The SDWA provides for a Federal/State cooperative effort to prevent endangerment of underground drinking water sources from industrial and municipal waste disposal wells, oil-field brine disposal wells and secondary recovery wells, and engineering wells. At present, neither surface impoundments nor landfills are included in this program. The SDWA does, however, require that EPA conduct a survey of methods used for waste disposal and means of controlling such waste disposal. The survey, started shortly after the SDWA became law in 1975, facilitated the evaluation of the impact of both hazardous and municipal waste disposal practices on existing and future underground sources of drinking water. The findings from this survey indicated that waste disposal practices have adversely affected the safety and availability of ground-water resources. However, the SDWA does not carry the statuatory authority to regulate land disposal of solid wastes, land application of sludges and effluents, or use of septic systems except under the emergency powers provisions of the Act (18).

The Solid Waste Disposal Act of 1965 contains no specific reference to ground water; however, guidelines developed under the Act provide for ground-water protection from pollution activities and surface drainage. There are also site development guidelines which conside. the impact on ground water. These guidelines are only mandatory for Federal agencies (18).

The NEPA requires Federal agencies to prepare environmental impact statements (EIS) on major Federal or Federally funded actions. Ground-water protection is a

In addition to the study, HSWA states that the revisions to the Criteria "shall be those necessary to protect human health and the environment and may take into account the practicable capability of ..facilities [to implement the Criteria]. At a minimum, [the] revisions...should require ground-water monitoring as necessary to detect contamination, establish criteria for the acceptable location of new or existing facilities, and provide for corrective action as appropriate."

3.1.2 Present Status of RCRA Subtitle D Program

In response to the concerns regarding environmental and human health impacts from municipal solid waste facilities, the 1988 Draft Report to Congress details the present status of the RCRA Subtitle D program. An inventory and evaluation of Subtitle D facilities concluded that there are approximately 226,000 such facilities throughout the United States. Presently more than 11 billion tons of Subtitle D wastes are being produced annually with greater than 95 percent of these wastes being industrial nonhazardous waste, oil and gas waste, mining waste, and municipal solid waste. Approximately 85 percent of the Subtitle D facilities which dispose of these wastes are surface impoundments, 8 percent are land application units, 6 percent are landfills and 2 percent are industrial waste piles. The report states that, of the total volume of municipal solid waste generated in 1984, 85 percent was disposed of in landfill units. The report went on to stress that although design and operating characteristics of the Subtitle D facilities differ significantly, depending upon the composition and physical form of the wastes, environmental impacts from such facilities present a unique management problem and risk to human health and the environment (17).

The 1988 Draft Report to Congress stressed that violations of state regulations, case study evidence, risk characterization studies, waste and leachate characteristics, and the current limited use of design controls clearly indicate that MSWLFs have contaminated the environment and that there is a potential for such damages to continue in the future. In conclusion the Report specified that current inadequacies within both the Federal and State Subtitle D programs failed to protect human health and the environment from potential adverse impacts from MSWLFs (17).

3.2 Leachate Generation

A major environmental concern regarding the disposal of municipal solid wastes into landfill units is the generation of leachate. The term leachate has been applied to highly contaminated water contained in or directly associated with a refuse disposal site. Leachate generation occurs when the various organic compounds in the waste are decomposed or stabilized by aerobic and anaerobic microorganisms and converted to gases and soluble organic and inorganic compounds. When a sufficient amount of water comes into contact with the waste, these compounds can dissolve and travel with the water that recharges or discharges into adjacent surface water bodies or the ground-water reservoir (15).

The volume of leachate generated and migrating from a landfill site depends on such factors as availability of water, landfill surface conditions, refuse conditions, and underlying soil conditions. Sources of water available for leachate generation include direct precipitation, surface run-on, ground-water intrusion (mounding), irrigation, surface ponding, refuse decomposition, and codisposal of liquid waste or sludges with refuse. The primary contributor is direct precipitation (20). For example, a 100-acre landfill receiving 42 inches of water per year in precipitation is capable of producing 57 million gallons of leachate per year. The inability to control such factors ultimately results in the production and off-site migration of leachate from MSWLFs. The ensuing impacts to water resources results in a substantial risk to human health and the environment.

Water reaching the landfill surface can either evaporate, transpire, infiltrate through the landfill surface, or leave the site as surface runoff (20). These water distribution pathways principally depend upon the surface conditions of the landfill and the presence or absence of control mechanisms. Landfill surface controls, such as vegetation, cover materials, runon/runoff controls, and proper grading, when inadequate or nonexistent, can result in increased leachate generation.

Underlying soil conditions and/or control technologies can modify both the rate and amount of leachate migrating from MSWLFs. The amount of leachate migrating from the landfill is dependent upon the soil permeability and absorption capacity of the soils beneath the ill. Landfills located in highly permeable soil areas will tend to have a higher rate of leachate dispersion from the landfill. In areas of lower permeable soils, the flow of leachate will be greatly retarded. Hydraulic barriers (bottom sealers, synthetic liners, slurry trenches, grout curtains, sheet piling cutoff walls, etc.), which may be present at the MSWLF, are designed to either prevent groundwater from flowing through the landfill and generating leachate or control the movement of leachate away from the landfill (20).

Evidence that leachate is migrating from MSWLFs includes increased levels of biological oxygen demand (BOD), chemical oxygen demand (COD), heavy metals (such as iron, chloride and nitrate) and other toxic compounds in ground and/or surface water in the vicinity of the MSWLF. The increased concentrations of metallic ions in local ground water and surface water occurs when percolating waters slowly dissolve solid inorganic wastes and migrate off site. Other reactions which occur in and around MSWLFs include the interaction of carbon dioxide with indigenous soil and rock materials, as water travels through permeable soils, contributing to the hardness of the ground water and the release of iron and manganese held by soil particles (15).

The concentration of chemical and biological contaminants in ground water will generally decrease with the distance travelled from the landfill. The contaminants are involved in a variety of physical and chemical processes, such as adsorption, ion exchange, dispersion, and dilution as they migrate through the unsaturated and saturated soils beneath the site. The effectiveness of these processes to limit the adverse impacts to human health and environment depend on the characteristics of contaminants, soil underlying the landfill, and geologic and hydrologic conditions at the site.

The effects of poorly sited landfills and/or inadequate leachate control technologies pose a severe threat to ground-water and surface water resources, and ultimately to human health and the environment. There is not much information on how long a landfill will continue to generate leachate; however, there are some indications that a landfill closed over 20 years still generates leachate (15).

3.3 Ground-Water Contamination

Until the 1970's, geologic and hydrologic conditions were seldom considered in siting landfills. Landfills were generally placed on land that had little or no value for other uses; hence many landfills were located in marshlands, abandoned sand and gravel pits, old strip mines, and limestone sinkholes, all favorable environments for the generation of leachate and, subsequently, ground-water contamination. As landfills in the 1970's did not have ground-water monitoring programs, contamination from the landfills was first observed when the discharge of contaminated ground water had affected the better-monitored surface waters or until cases of water-supply well contamination had increased dramatically. In some cases, wells had to be abandoned due to contamination. For example, the City of Newark, Delaware, lost about 10 percent of its well-supply capacity because of contamination linked to the community landfill.

An EPA study of ground-water contamination in the northeast states, conducted in 1974, indicated hundreds of cases of ground-water contamination in this region. The study examined the various States' methods for disposal of municipal solid wastes and concluded that the principal reasons for the problems that were occurring were the acceptance of hazardous waste, poor location, and technological control deficiencies in waste management operations (e.g., open dumping) (15).

Another investigation of solid waste disposal sites, performed by EPA in 1976, indicated that ground water was contaminated on a local basis in all parts of the nation. The degree of contamination varied from slight contamination to serious contamination with heavy metals, organic and radioactive materials. In some heavily populated and industrialized areas, high incidents of contamination precluded the development of water wells. The survey also indicated that removing the source of contamination does not clean up the aquifer or resolve the problem. The contamination renders the aquifer useless as a drinking water source for decades and possibly centuries. The resulting consequences were serious local economic problems because of the loss of ground-water supplies.

The 1976 survey also found that, prior to 1976, 80 percent of wastes were landfilled illegally; only 20 percent of wastes were placed in authorized disposal sites. Most of the then existing sites were open dumps, or poorly sited and operated landfills, and many of them accepted industrial wastes. Landfilling was the cheapest method of waste management at that time and about 90 percent of industrial hazardous wastes were landfilled along with municipal wastes. The survey estimated that the

the landfills received approximately 135 million tons of refuse per year. The resulting impacts of the waste disposal process was that the 18,500 municipal landfills generated 90 billion gallons of contaminated leachate per year on a total area of 500,000 acres.

A 1976 United States Geologic Survey (USGS) investigation of the quality of water in Southeast Nassau County, New York, indicated elevated concentrations of nitrate, chloride and total-solids in the ground water. All the contaminants were migrating within the principal water supply aquifer for the county. The source of these contaminants appeared to be the municipal waste management system. As a result, the USGS report concluded that there is a trend toward increased concentrations of nitrate, chloride and total-solids concentrations in wells in the proximity of MSWLFs (19).

Another USGS investigation was conducted to determine the extent of ground-water deterioration on Long Island. This investigation indicated the presence of leachate plumes between two principal city landfills. The ground water had elevated levels of sodium, potassium, calcium, magnesium, and other compounds and ions. This study observed a downward movement of the contaminants within the aquifer as a result of the leachate's greater density. Both landfills are located on a highly permeable soil approximately 74 to 170 feet thick. Many drinking water wells were located in the aquifer downgradient of the landfills. The changes in the quality of water were severe, particularly near the landfill. As the water flowed away from the site, dilution and sorption of the contaminants reduced the severity of the release; however, the size of the plume increased for many years after waste disposal had ceased (14).

EPA conducted an additional Subtitle D facilities survey in 1986 to collect background data on the design and operation of municipal, nonhazardous waste landfills in selected Regions. The survey confirmed environmental contamination problems may be induced by municipal landfills and their operation (1).

Another study conducted by EPA in 1984 evaluated over 900 hazardous waste sites. Nearly half the sites were landfills and many of these were municipal waste disposal sites that accepted or were suspected of accepting some hazardous waste. A majority of these units had contaminated or were suspected of contaminating ground or surface water. Landfills evaluated in the study usually did not have a bottom liner or leachate collection system and were located in soils of moderate to high permeability.

3.4 Surface Water Contamination

Surface water contamination from MSWLFs can occur under a variety of circumstances. Case studies have documented incidents of releases to surface waters caused by inadequate surface runoff controls and drainage patterns which resulted in contaminated run-off, location of MSWLFs in floodplains and wetlands, erosion and transport of contaminants by streams or creeks flowing through the MSWLFs, and leachate lagoon washouts or berm ruptures. These incidents generally are one-time events and resulted in a limited amount of low-concentration contaminants being released to surface waters. Because natural streams and waterways are subject to the cleansing action of turbulent flow and the purifying effects of air, light, and biological organisms, the recovery period of surface water from contaminant exposure is less than that of ground water rendering the impacts less severe (18). However, MSWLFs do pose a major threat to surface water resources. The direct discharge of heavily contaminated leachate into surface waters represents a means of continuous contamination from which natural recovery may be difficult and time consuming. The resulting consequences are a loss of recreation, agricultural, and drinking water uses of surface water as well as environmental degradation, fish kills, and other adverse impacts.

The case studies presented in this report identify the types of releases from MSWLFs and their impact on surface water resources. However, the information on the extent of the impacts, effects on human health and the environment, and applied mitigation measures was very limited. The case studies often focused on the hydrologic interconnection between ground water and surface water and how impacts to one resource correlated to impact to the other.

4.0 HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFS

The purpose of this Section is to describe various types of human health and environmental impacts that have occurred as a result of ground or surface water contamination at MSWLFs. One hundred and sixty-three (163) case studies were selected which provided adequate information about adverse impacts. These case studies are summarized in Table 1 of Section 6.0. The sources reviewed to obtain the selected cases are listed in Section 7.0.

For the purposes of this report, adverse impacts had occurred if the information on the site specifically stated that damage had occurred to water or environmental resources. Examples of adverse impacts were loss of wildlife, contamination of ground or surface water resources, and elevated levels of indicator parameters or contaminants. The severity of the impact was then evaluated based on the following information, if available:

- the concentration of the contaminants found in the ground or surface water versus State or Federal standards,
- whether on or off-site resources had been damaged, and
- the type of corrective action, if any, that had been initiated.

The types of adverse impacts identified were classified as either ground-water contamination (146 sites), surface water contamination (71 sites), or ecological damage (13 sites). In several cases, more than one type of impact occurred, at a particular site. The total number of impacts, therefore, exceeds the total number of sites.

The types of impacts were also categorized based on whether the resources damaged were on-site or off-site, as follows:

- Off-site Impacts

  - 71 MSWLFs have resulted in off-site impacts; 56 to ground water (53 documented, 3 suspected), 37 to surface water (32 documented, 5 suspected), and 13 to fish or wildlife (7 documented, 6 suspected).

  - 33 MSWLFs have had documented adverse impacts on private or community water supply systems (including one surface water supply), 3 sites threaten such systems, and 9 sites are suspected of having damaged such systems.

  - 58 MSWLFs have initiated some type of remedial action. Of these, 23 required alternate drinking water supplies or abandonment of wells, 18 required site closure, 25 with design or operating improvements including the collection and treatment of contaminated ground or surface water; and 23 needed further investigation.

  - One (1) MSWLF is under litigation.

  - 13 MSWLFs have not identified any remedial actions.

- On-site Impacts

  - 92 MSWLFs (without any off-site impacts) have resulted in on-site impacts: 85 to ground water (84 documented, 1 suspected) and 34 to surface water (27 documented, 7 suspected). (Five additional sites were identified as contaminating both on- and off-site ground water.)

  - 40 MSWLFs have initiated some type of remedial action; 13 site closures, 21 with design or operating improvements including collection and treatment of contaminated ground or surface water, and 19 needed further investigations.

  - One (1) MSWLF is under litigation.

- 52 MSWLFs have not identified any remedial actions.

The following sections further discuss the types of impacts that have been identified.

4.1 Ground-Water Impacts

As stated above, 146 sites were identified as having contaminated ground water: 90* contaminating on-site ground water (89 documented, 1 suspected) and 56 contaminating off-site ground water (53 documented, 3 suspected). For 43 sites, the information available did not specify the contaminants found; however, for those that did, the types of contaminants varied from organic and inorganic toxicants to indicators of pollution (e.g., COD, TOC, BOD).

Organic contaminants were identified in ground water at 65 sites: 29 in off-site ground water and 36 in on-site ground water. This does not necessarily imply that organic toxicants were not present at the other sites since it was not possible to determine whether analyses had been conducted for such constituents. It appears, however, that organics were reported because of the elevated concern at their presence. The most common indicators of organic contamination noted were VOCs and TOCs. The most common specific compounds identified were trichloroethylene, benzene, vinyl chloride, and toluene. In several cases, the concentration for a particular constituent exceeded EPA-established MCLs.

Inorganic contaminants or elevated levels of indicator parameters were identified in ground water at 77 sites: 27 in off-site ground water and 50 in on-site ground water. As with organics, lack of identification does not mean that the constituents were not present at the other sites. Unlike organics, however, it is likely they were measured at all sites because monitoring for these contaminants and parameters is common. As would be expected, the constituents most often reported were iron, chloride, manganese, COD, sulfate, and total dissolved solids, which are the most

*Five (5) of the 90 were also identified as contaminating off-site ground water.

commonly used indicators of ground-water pollution from MSWLFs. Less frequently reported inorganics included cadmium, lead, chrome, and arsenic. Again, it could not be determined whether this is a result of their not being analyzed for or their not being present.

Federal or State drinking water standards were reported as having been exceeded at 25 sites; 11 times for the Primary Drinking Water Standards and 19 times for the Secondary Drinking Water Standards. In several cases, however, drinking water was reported to be rendered unfit for consumption without specifying the contaminants of concern. Overall, 35 sites have had adverse impacts on private or community ground-water supplies (including 3 that are threatening public supplies) and 9 sites are suspected of having adverse impacts. These adverse impacts have resulted in wells being abandoned, the necessity for additional treatment, and/or loss of capacity. In one instance, the capacity of a large community well field was reduced by 50 percent in an attempt to alter ground-water flow characteristics and the migration of contaminants.

Some type of corrective action was reported at 85 MSWLFs as a result of ground-water contamination. These actions ranged from merely investigating the problem further to the recovery and treatment of the contaminated ground water. Measures were taken either to curtail further ground-water contamination from existing sources (e.g., through proper closure of problem areas), prevent contamination from new sites (e.g., installation of new units with liners and LCSs), or to ensure that human populations were not exposed to the contaminants (i.e., providing alternative drinking water supplies).

Improvements in the design features and operating requirements were the most common actions taken (35 sites) as a result of ground-water contamination. These improvements included the installation of liners and leachate collection systems (LCSs) in new cells of existing facilities and/or increasing the capacity of run-on diversion and run-off collection systems. Where drinking water supplies were contaminated, alternative sources of water were provided to the affected parties (17 cases). The second most common action was site closure. Twenty-seven (27) MSWLFs were partially or completely closed in response to the contamination. Site closure usually consisted of regrading; in some cases it included the installation of an impermeable cover to reduce leachate generation.

It should be noted, that in only a few cases (13), measures were taken to prevent existing ground-water contamination from migrating further from the site or to remove the contaminants from the ground water. These measures included the installation of slurry walls and/or pumping and treating ground water. These measures were usually taken when productive well fields were threatened.

4.1 Surface Water Impacts

In general, surface water impacts were not as well documented as ground-water impacts. Although 71 cases of surface water contamination (59 documented, 12 suspected) were identified, only 35 provided any information concerning the contaminants of concern. Information on the remaining sites merely indicated that surface water contamination had occurred. The most common constituents identified were VOCs and metals. In general, the severity of the impact was not well documented. Nine (9) of the 12 suspected cases of surface water contamination, were identified as having leachate discharges to surface water with no documented damages. In these instances it was reported that contaminants were diluted to baseline levels or that dilution had eliminated the problem. No information was supplied, however, as to how these conclusions were reached.

Where documented, most cases of surface water contamination appear to be a result of the direct discharge of leachate via seeps or springs to surface water. Information on the remaining sites did not indicate how the contamination had occurred. No cases of surface water contamination via bank seepage were reported.

Corrective action was initiated at 40 of the 71 sites that exhibited surface water contamination. In 30 of these cases, the corrective action also addressed ground-water problems. A majority of the actions (21) involved improvements to the design and operation of the landfill, usually in the form of improved drainage or through the collection and treatment of contaminated run-off. In 7 cases, sites were ordered closed and in 20 cases further investigation was required.

4.3 Ecological Impacts

Damage to wildlife or ecological habitats were the least documented types of impacts noted from MSWLFs. Only 13 cases of this type of damage were located (7 documented, 6 suspected).

Twelve (12) case studies indicated that leachate discharges from MSWLFs resulted in adverse impacts to fish populations in nearby surface waters or to local flora and fauna. Little information was available concerning the magnitude of the damage or the contaminants that caused the problem. One case study, however, provides some insight as to why few instances of adverse impacts to wildlife or ecological impacts from MSWLFs may have been documented. In this instance, a 5-year study was conducted by the United States Geologic Survey to determine the effects of a MSWLF on the biology of a nearby stream. During this period, numerous samples of ground water, surface water, stream sediments, and the flora and fauna within the stream were collected in the vicinity of the landfill. It was found that the benthic invertebrate populations upstream of the landfill were noticeably different from those in the portion of the stream receiving leachate-contaminated ground water or spring water. Benthic invertebrate populations are useful indicators of water quality because, unlike larger forms such as fish, they are unable to migrate to escape lethal conditions such as low dissolved oxygen (DO) concentrations (9). The study found the following:

- Species of benthic organisms not resistant to pollution were absent in the stream reach affected by the landfill. The major cause appears to be elevated levels of metals, particularly iron and manganese from leachate contaminated ground water, found in the benthic sediments.
- Algae was replaced by fungi and filamentous bacteria in the affected area.
- Low DO concentrations in the stream, resulting from the introduction of leachate, selectively eliminated organisms unable to withstand a prolonged deficiency of DO.

- Although ground water entering the stream was severely degraded and would be toxic to many benthic organisms, stream-water quality was generally good because the contaminants of concern, iron and manganese, precipitated quickly upon entering the stream.

The above discussion indicates that adverse impacts to wildlife and ecological habitats from MSWLFs can occur. It also illustrates, however, that unless the damage is catastrophic, evidence of the damage may not be immediately visible. The damages cited in the latter case study were only evident after 5 years of extensive field work and study. It should be particularly noted that the primary indicator through which regulatory agencies would normally determine if something is wrong, that is water quality, did not prove reliable.

5.0 RELATIONSHIP OF DESIGN, OPERATION, AND LOCATION TO IMPACTS FROM MSWLFS

The purpose of this Section is to describe the role that design, operation, and location may play in any ground or surface water problems that have occurred at MSWLFs. Case studies were selected from those used in Section 4.0 and listed in Table 1 of Section 6.0, for which sufficient data on the design, operation and location were available. The majority of this information came from two sources: an EPA survey of MSWLFs conducted in 1986(1) and a 1984 EPA study of facilities that managed hazardous waste (2). Extensive records were available for the former study; these cases are discussed in Section 5.1 and in Table 2 of Section 6.0. Less extensive data are available in the latter study; this information is provided in Section 5.2 and in Table 3 of Section 6.0.

5.1 Well-Documented Sites

The data for the sites addressed in this section were obtained during the 1986 EPA survey of MSWLFs (1) as discussed in Section 3.0. The survey selected 114 facilities to provide a cross-section of the technologies employed to manage solid waste. Environmental damages were common at the surveyed sites. The most typical damage was ground-water contamination. The number of sites with contaminated ground water may be higher than the survey indicated due to the absence of ground-water monitoring programs at some facilities. The survey concluded that the type, frequency, and extent of environmental damages depended on the hydrogeologic setting and the design and operation procedures of the facility (1).

Fifty-three (53) sites out of 114 were selected for further evaluation in this study of ground-water/surface water damages at MSWLFs because sufficient information on these sites were available: 46 reported ground-water contamination, 17 had documented surface-water contamination, 1 had suspected ground-water contamination, and 5 had suspected surface water contamination (see Table 2 in Section 6.0). Ten (10) had documented contamination of both surface water and ground water.

Groundwater

Forty-two (42) of the sites with ground-water contamination did not have bottom liners. Sixteen (16) of these facilities had liners installed in the new sections of the landfill after ground-water contamination was detected or suspected. Eight (8) sites had "natural liners" which consisted of a layer of native soil of variable thickness at the bottom and 15 were equipped with engineered liners. The engineered liners included compacted native and imported soils, compacted mixtures of native soil and bentonite, asphalt, and synthetic membranes

All sites with "natural liners" and several with engineered liners experienced some degree of ground-water contamination. It appears that inadequately designed or poorly constructed liners, lack of a leachate collection system, or inadequate runon/runoff control systems may have contributed to the problem.

Most sites were equipped with final covers usually constructed of compacted soil (clay if available) covered with a layer of topsoil for vegetation. In some cases, however, these covers appear to have been constructed of permeable material, improperly graded, and/or of insufficient thickness. Such conditions combined with the lack of liner and LCS, may have been an important contributor to ground-water contamination.

Twenty-three (23) landfills with ground-water contamination were equipped with LCSs. Fifteen (15) of them were installed on the expanded areas of the old landfills; thus, they did not collect leachate from the old sections of the landfills that were contributing to the problem. The remaining 8 facilities were reported to have LCSs that were inadequately designed or constructed.

Most of the evaluated sites maintained some type of runon/runoff control systems. However, many of the control systems did not appear to work properly due to inadequate design, construction, or maintenance. Improperly controlled surface water, therefore, was available for leachate generation and migration.

The hydrogeologic setting of several sites also appeared to be an important factor contributing to ground-water contamination. Most of the affected sites are either in areas of permeable soils, wetlands, karst topography, lowlands, floodplains, or above important shallow aquifers. Such locations allow rapid dispersion of contaminants and are conducive to ground-water contamination.

Many of the sites were located in areas that receive relatively large amounts of precipitation, which is a major source of water for leachate generation. States, such as Oregon, Wisconsin, and Florida, recognized this problem and the need for upgraded ground-water protection after experiencing serious contamination problems, partially due to leachate generation. These States were found to have required the most environmental controls at their landfills, primarily leachate collection systems.

Surface Water

The incidents of surface water contamination resulted from a variety of factors including locating within a wetland or floodplain, poor runoff controls resulting in leachate generation, off-site surface migration, inadequate drainage causing leachate ponding, and direct discharges of leachate into lakes, rivers and streams. Of the 22 case studies with documented and/or suspected surface water contamination problems, 17 were the result of either poor run-off controls or; inadequate drainage systems; 2 had documented direct leachate discharges to surface waters and 4 were located in floodplains or wetlands.

5.2 Generally-Documented Sites

The 1984 EPA study (2) evaluated 926 randomly-selected hazardous waste sites. Three hundred and ninety-six (396) were landfills, about 40 percent (158) of which can be characterized as MSWLFs that, prior to RCRA enactment, accepted some hazardous waste. Of these MSWLFs, 58 with documented and suspected ground-water and surface-water contamination problems were selected for this report. These cases are summarized in Table 3 in Section 6.0. Fifty-one (51) reported ground-water contamination, 3 were suspected of contaminating ground water, 27 reported surface-water contamination, and 6 sites were suspected of contaminating surface water. Twenty (20) of these landfills reported contamination of both surface water and ground water.

The landfills evaluated in the study had surface areas ranging from 5 to 400 acres and generally contained significant quantities of liquids, pumpable sludges and/or drummed wastes. The landfills were usually constructed without a bottom liner or leachate collection system. The majority of the facilities were located in moderate to highly permeable soils within 20 feet of ground water and within 100 feet of a surface water body. Approximately 30 percent of the facilities were within one-half mile of shallow drinking water wells and were frequently located on sites contiguous to residential properties

The facilities were typically constructed with poor or nonexistent surface drainage controls and had inadequate operation and maintenance procedures. Most of the landfills did not have enough cover although, in the majority of cases, wastes were covered periodically with fill material. Many of the landfills did not have adequate ground-water or surface water monitoring programs.

The exact cause of the contamination could not be determined for several sites because of inadequate information. However, it may be assumed that the primary reason for contamination was the lack of environmental controls, coupled with inadequate landfill siting.

The common characteristics of most of the reviewed sites include lack of, or inadequate, environmental controls (42 sites, 72 percent of the sites), past disposal of hazardous wastes (25 sites, 43 percent of the sites), presence of a shallow aquifer below the site (16 sites, 28 percent of the sites), and permeable soils (20 sites, 34 percent of the sites).

6.0 GROUND-WATER/SURFACE WATER CASE STUDIES SUMMARY TABLES

The tables in this section summarize the information discussed in Sections 4.0 and 5.0. Table 1 presents the data used in Section 4.0 and Tables 2 and 3 present the data discussed in Section 5.0. Tables 2 and 3 are subsets of Table 1. Sources for the case studies are provided in the reference after the site name and are listed in Section 7.0.

Table 1 provides the name, location, age or operating dates, status, media impacted, description of impacts, and nature of any corrective taken for the MSWLFs at which human health or environmental impacts have occurred. Footnotes indicate the source of the information. The status of a landfill, whether active (A) or closed (C), is for the time the information was reported. Age of the landfill, when operating dates are not provided, indicates the age of the facility when the information was reported, not necessarily the current age of the facility. Each site is numbered and these numbers are consistent in all three tables.

Tables 2 and 3 indicate the correlation between a specific site's environmental setting, its waste management design and operational characteristics, and damages to ground-water and surface water resources. These correlations are identified as linkages, which range from sites being located in highly permeable geologic conditions to sites with design deficiencies (e.g., no liners, inadequate runon/runoff controls).

Table 2 provides information about the 53 case study sites used in Section 5.1. These case studies, a subset of Table 1, have well documented evidence of damages to ground water and/or surface water by contaminants from MSWLFs. The impacts can be directly related to the site's location and/or environmental management operations. Unless otherwise noted, all the information in Table 2 was derived from the 1986 EPA survey (1).

Table 3 identifies 58 additional case study sites that have documented and/or suspected ground-water and/or surface water contamination problems. The case study sites identified in Table 3 vary, however, from those identified in Table 2. These landfills can be characterized as MSWLFs that, prior to RCRA enactment, accepted some amounts of hazardous wastes. Another difference between the two tables and corresponding sites is the availability of data. Though the data presented in Table 3 are not as extensive as in Table 2, there was enough reliable information available to evaluate these 58 facilities in terms of their location, design and operation, and environmental degradation. Unless otherwise noted, the information in Table 3 was derived from the EPA 1984 State Survey (2).

Tables 2 and 3 contain 5 headings: 1) specific case study site names, 2) documented or suspected damages to ground-water and/or surface water resources, 3) environmental setting descriptions (soil permeability, shallow ground water, located in a floodplain or wetlands, etc.), 4) waste design and operation characteristics (no liners, inadequate leachate collection systems, lack of monitoring wells, etc.), and 5) linkage. The linkage section interprets the correlations between environmental setting and landfill design and operations that have been documented or are suspected to be cause of a release of contaminants.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
1) West Bend Sanitary Landfill, Wisconsin (3h)	23	C	GW	• VOC contamination • MCL's for: - trichloroethylene - 1,1-dichloroethane - 1,2-dichloroethylene - benzene (all carcinogens) exceeded in on-site and off-site domestic (60) wells	• Private homes (60) temporarily supplied with activated carbon filters • Private homes to be connected to public water • Investigation continuing
2) Delafield Sanitary Landfill, Wisconsin (1)	1956-1983	C	GW	• Off-site domestic wells show degradation above National Secondary Drinking Water Standards (NSDWS)	• Site ordered closed
3) Black River Falls Landfill, Wisconsin (1)	1943-1973	C	GW	• Off-site domestic wells (4) rendered unfit for human consumption in 1973 • On-site wells continue to show elevated levels of Fe and specific conductance	• Alternative water supplied to residences • Site capped to reduce infiltration • Plume to be allowed to disperse naturally

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
4) Carroll County Sanitary Landfill, Arkansas (1)	1970-1985	C	SW, GW	• Creek adjacent to landfill contaminated by leachate seeps • GW may also be affected because of creek recharge	• Site ordered closed • Corrective action plan to be developed
5) Litchfield Landfill, Connecticut (1)	1930-Present	A	GW,SW?	• Off-site domestic wells (2) contaminated • Contaminated surface water discharged to wetlands, ponds, and nearby river - effects not reported	• Private homes connected to public water • Site ordered closed
6) Sauk Co. Solid Waste Management Site, Wisconsin (1)	1973-1981	C	GW	• Plume identified and is moving off-site	• Site ordered closed • Site capped to reduce infiltration
7) Tolland Landfill, Connecticut (1)	1965-1981	C	GW	• Off-site domestic wells (12) contaminated with metals and organics	• Private homes connected to public water
8) South Windsor Landfill, Connecticut (1)	1950-1979	C	SW, GW	• Off-site domestic wells and SW contaminated	• Private homes connected to public water • No reported action for SW

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
9) Canton Landfill, Connecticut (1)	1965-1982	C	SW, GW	• Shallow and bedrock aquifer contaminated • Off-site domestic and industrial wells contaminated • Detrimental impact on Class B/A brook documented	• Private homes and industries connected to public water • Site ordered closed
10) Lena Road Landfill, Florida (1)	19	A	SW, GW	• Off-site GW and SW contaminated with VOCs • Off-site domestic wells contaminated	• Slurry wall constructed with leachate collection system (LCS) • One domestic well abandoned
11) Northwest 58th St. Landfill, Florida (1) (3c)	35	A	GW	• One square mile of Biscayne Aquifer (sole-source) contaminated with metals, VOC's, and pesticides • Major community well fields closed	• Well fields closed • Site on NPL and being investigated
12) Lantana Road Sanitary Landfill, Florida (1)	-	-	GW	• Off-site contamination of GW; high concentrations of benzene threatening domestic wells	• Landfill ordered closed • Alternative water supplied to residents • Environmental impact study being conducted

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
13) Hillsborough Heights Sanitary Landfill, Florida (1)	8	A	GW	• Off-site GW contaminated with: - trichloroethylene - 1,1-dichloroethylene - vinyl chloride all above MCL's • Off-site domestic wells threatened	• Private homes given option to connect to public water by Court Order
14) Tillamook County Landfill, Oregon (1)	38	A	SW, GW	• Off-site GW and SW contaminated • NSDW standards exceeded in wells • SW noticeably degraded (odor, color, appearance)	• Retrofit with covers, liners, and LCSs required by Court Order
15) Rossman's Landfill, Oregon (1)	18	C	GW	• Off-site ground water contaminated • Community water supply wells contaminated	• Legal action being taken by community against owner

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
16) Llangollen Landfill, Delaware (10)	1960-1968	C	GW	• Off-site domestic wells contaminated and community wells threatened • Toluene, benzene, and trichloroethylene present in significant amounts	• Private wells connected to public water • Well field reduced pumpage by 50% • Counter - pumping and discharge to creek
17) Peoples Avenue Landfill, Illinois (11)	1947-1972	C	GW,SW?	• Off-site domestic (4), industrial (4), and public (1) wells contaminated. Loss of approximately 7.3 MGD capacity • Leachate discharge to river - effects not reported	• Private homes and industries connected to public water • Public well abandoned and replaced
18) Fox Valley Landfill, Illinois (13)	1961-1972	C	GW	• Off-site domestic wells (7) contaminated (strong odor, black color)	• Private homes connected to public water
19) South Cairo Municipal Landfill, New York (9)	1970-1975	C	SW, GW	• Off-site GW and SW contamination • Benthic organism diversity less down-stream than up-stream of landfill. Only tolerable species survived due to metal concentrations	• None

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
20) Hipps Road Landfill, Florida (3c)	1960's	C	GW	• Off-site domestic wells contaminated with: - vinyl chloride - methylene chloride - toluene	• Private homes (141) connected to public water • NPL site - Site to be capped and GW pumped and treated at POTW
21) Taylor Road Landfill, Florida (3c)	1975-1984	C	GW	• Off-site domestic wells contaminated with VOCs	• All homes connected to public water • NPL site - Investigations currently under way
22) Granby Landfill, Connecticut (5)	1950's-1986	C	GW	• Off-site domestic wells contaminated with: - acetone - methyl isobutyl ketone - methyl ethyl ketone (exceeds EPA Health-based criteria) - toluene • On-site GW exhibited elevated levels of organics	• Site closed and capped

* Age at time of eport or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
23) Marshall Landfill, Colorado (3b)	-	-	SW	• Off-site public water supply (SW) contaminated	• State Superfund Site - Leachate diverted and treated
24) City of Lampasas, Texas (3d)	1974-Present	A	SW	• Off-site SW contaminated resulting in fish kill in 1987 from run-off	• Rechanneled drainage, stopped leachate seeps, and constructed new ponds
25) Pisgah Landfill, Maryland (3e)	1960's-Present	A	SW,GW	• Off-site domestic wells contaminated with inorganics and low level organics • On site SW contaminated with VOCs and organics	• Alternative water supplies (new wells) and carbon filters provided
26) Reichs Ford Road Landfill, Maryland (3e)	-	-	SW,GW	• Off-site river contaminated by on-site contaminated stream • GW contamination documented	• Contaminated on-site stream to be treated
27) City of Baraboo, Wisconsin (3h)	1970-Present	C	GW	• Off-site domestic wells (6-8) contaminated with VOCs • VOCs found at depth in bedrock aquifer	• Private homes connected to public water • Investigation continued • Site ordered closed

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
28) City of Merrill, Wisconsin (3h)	1973-1987	C	GW	• Off-site domestic well contaminated with VOC's • Primary and secondary drinking water violations	• Site ordered closed
29) City of O'Conto Falls Landfill, Wisconsin (3h)	1960's-Present	A	SW	• Leachate discharges to trout stream resulting in unspecified impacts to trout population and stream sediments	• Under a Consent Order to construct French Drain
30) Bozeman Landfill, Montana (3f)	15	A	GW	• Leachate plume migrating off-site towards public water supply	• Investigations being performed to assess threat • Measures to minimize leachate generation being taken
31) Scratch Gravel Landfill, Montana (3f)	15	A	GW	• Off-site GW exhibits elevated levels of Cl and pesticides	• Monitoring to determine threat to nearby water users
32) Jackson Township Landfill, New Jersey (2)	15	C	GW	• Off-site migration of volatile organics • 100 drinking water wells impacted • Human health impacts reported	• 100 drinking water wells closed • Alternative water supplied to residences • Installation of ground-water recovery and treatment system • Site ordered closed

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
33) Charles George Reclamation Trust, Massachusetts (2)	37	C	GW	• Off-site migration of volatile organics, BNEs and metals • Human health impacts • Drinking water wells contaminated	• Drinking water wells closed • Alternative water supplied to residences • Site ordered closed • Site on NPL and being investigated
34) Sidney Landfill, New York (2)	1964-1972	C	SW, GW	• Off-site GW contaminated with metals • Drinking water wells contam nated • Site drains into Sidney center water supply • Localized swamp impacted • Dead vegetation	• Drinking water wells closed • Extensive sampling program required • Hydrological investigation required
35) Site T, Region VII, Iowa (2)	Unknown Closed in 1971	C	SW, GW?	• Off-site SW contaminated with metals and volatile organics • Impacts to flora and fauna • Suspected contamination of GW	• Hydrological investigation required • Extended sampling program for SW, GW and leachate • Installation of runon/runoff diversion system

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
36) Huntington TWP Landfill, New York (2)	29	C	GW	• Impacts to GW and property • Off-site GW contaminated with metals and VOCs • Domestic wells contaminated	• Site ordered closed
37) Dover Municipal Landfill, New Hampshire (2)	1958-1980	C	SW,GW	• Off-site GW and SW contaminated with metals and VOCs • Property damages • Domestic wells contaminated	• Domestic well closure • Hydrogeological investigation required • Increased ground-water monitoring • Increased leachate sampling program
38) Holden Town Dump, Massachusetts (2)	-	A	SW,GW	• Off-site GW and SW contaminated with VOCs • Plume of contaminants flows into tributary of major water supply for the Town of Boston	• Installation of sorbent structures in leachate plume • Hydrogeological investigation required
39) Pemberton TWP Landfill, New Jersey (2)	-	A	GW	• Off-site GW contaminated with VOCs • Impacts to drinking water sources	• Contaminated private wells forced to close

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
40) Landfill and Development Co., New Jersey (2)	-	A	GW	• Off-site GW contaminated with VOCs • Documented drinking water impacts • Human health impacts suspected	• Ground-water interceptors • Construction of storm water handling system • Off-site spray irrigation of contaminated GW
41) Glenville Town Landfill, New York (2)	17	A	GW	• Off-site GW contaminated with phenols, sulfates, nitrates, metals • Suspected drinking water damages	• Extensive remedial investigation study required
42) Site A, Region VII (2)	17	A	SW	• Off-site SW contaminated with heavy metals downstream of the landfill • Levels exceed ambient water quality standards • Leachate migrates towards local SW	• Extensive sampling program required
43) Shreveport Landfill, Louisiana (2)	-	A	GW	• Off-site GW contaminated with metals, cyanide, VOCs, and BNE • Drinking water wells damaged • Suspected human health impacts	• Hydrogeologic investigation and sampling

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
44) Landfill and Resource Recovery, Rhode Island (2)	60	A	SW,GW	• Off-site SW and GW contaminated with metals and VOCs • Suspected off-site impacts to fauna	• Additional investigations and evaluations required • Expanded GW monitoring program required
45) City of Saratoga Springs Landfill, New York (2)	-	A	SW,GW	• Off-site SW and GW contaminated with bis (2-ethyl hexyl) phthalate • Suspected off-site impacts to drinking water resources, food chain, and fauna	• CA unknown or not documented
46) Orange County Landfill, New York (2)	13	A	GW	• Off-site GW contaminated with phenols, sulfates, and metals • Documented impact to drinking water resources • Human health impacts suspected	• CA unknown or not documented • Recommended to contact families of contaminated wells to examine human health impacts
47) Fresh Kill Landfill, New York (2)	37	A	SW,GW	• Off-site SW and GW contaminated with metals and chlorides • Leachate flows off-site to local SW • Suspected off-site flora and fauna damage • Located in designated tidal wetlands	• Leachate containment system installation required

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
48) Tantalo Landfill, New ork (2)	29	A	SW?,GW	• Suspected off-site contamination of SW and GW by metals • High coliform counts in off-site domestic wells • Suspected drinking water and fauna damages	• Further site evaluations required
49) Queensbury Landfill, New York (2)	-	C (partially)	SW,GW	• Off-site SW contaminated with PCBs and metals • Off-site GW contaminated with metals • Suspected off-site drinking water contamination	• CA unknown or not documented
50) Mayer Landfill, Pennsylvania (2)	1965-1976	C	GW	• Off-site contamination of GW with chloroethane, benzene and benzaldehyde • Residential wells contaminated	• CA unknown or not documented

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
51) Delmar Township Landfill, Pennsylvania (2)	-	C	SW,GW?	• Off-site SW contaminated with phenols • Suspected GW contamination • Suspected impacts on off-site drinking water sources	• CA unknown or not documented
52) Harrison Avenue Sanitary Landfill, New Jersey (2)	-	C	SW,GW	• Off-site SW and GW contaminated with chlorides and ammonias • Suspected impacts to off-site drinking water, flora and fauna	• No CA activity as directed by EPA
53) Gloversville Landfill, New York (2)	35	A	GW,SW?	• On-site GW contaminated with inorganics, phenols, benzene and VOCs • Suspected SW contamination • Suspected contamination of off-site water supply	• None
54) Johnstown Landfill, New York (2)	40	A	GW	• Off-site GW contaminated with chromium, lead and zinc • Domestic wells contaminated	• None

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
55) Syosset Municipal Landfill, New York (2)	1936-1975	C	GW	• Off-site GW contaminated with manganese, iron, chlorides, and ammonia • Municipal wells contaminated	• None
56) Lauer I Sanitary Landfill, Wisconsin (1)	1959-1977	C	GW,SW	• On-site GW and SW contaminated • Fe and Cl above NSDW standards in on-site wells	• Site closed • Slurry wall and LCS installed
57) Coffin Butte Sanitary Landfill, Oregon (1)	34	A	SW	• Off-site surface water contaminated	• Expansion of leachate holding capacity and changes in operation
58) Grants Pass Landfill, Oregon (1)	20	A	GW	• On-site GW contaminated with organics • Vinyl chloride found greater than 15 times MCL	• None as yet
59) South Canyon Landfill, Colorado (1)	7	A	SW	• Leachate discharged at approximately 10 gpm to off-site creek	• D&O improvements
60) Fort Collins-Loveland Sanitary Landfill, Colorado (1)	24	A	GW,SW	• On-site GW and SW contaminated • Deeper aquifer may also be contaminated	• Interceptor trench recommended • Under investigation

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
61) Victoria City Landfill, Texas (1)	1982-Present	A	GW	• On-site GW exhibits increased levels of TOC, Fe, and NO_3 • Cd and Pb exceed MCLs	• None
62) Gainesville Landfill, Texas (1) (3d)	10	A	GW	• On-site GW exhibits Cl, SO_4, Mn, and TOC above State standards	• Slurry wall installed
63) Pearsall Road Landfill, Texas (1)	1967-1982	C	GW	• On-site GW exhibits elevated levels of TDS, SO_4 and Cl above NSDW standards and Cd, Cr, and Ag above MCLs	• Site closed
64) DFW Landfill, Texas (1)	15	A	GW	• On-site GW exhibits elevated levels of metals, Cl, SO_4 and TOX • SO_4, Mn, Fe, TDS and Cl greater than NSDW standards • Hg greater than MCL in one well	• None
65) Shelton Landfill, Connecticut (1)	17	A	GW,SW?	• On-site GW exhibits elevated levels of TDS, Cl, Na, Fe, N, and COD • Plume enters Farmhill and Houstonic rivers - impacts not documented	• None for GW

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
66) Hartford Landfill, Connecticut (1)	11	A	GW,SW?	• On-site GW exhibits TDS, SO_4, Cl, Fe, and Mn above NSDW standards and elevated Na, K, and specific conductance • GW discharges to wetland bordering Connecticut River - no documented impacts	• None
67) Cleburne Landfill, Arkansas (1)	5	A	GW	• On-site GW exhibits elevated levels of COD, TDS, and Cl • Mn, Fe exceed NSDW standards	• Resurface and vegetate closed areas
68) Central Disposal Sanitary Landfill, Florida (1)	25	A	GW	• On-site GW exhibits elevated levels of As, COD, P, phenols, and BOD greater than State Standards and Fe and N exceed NSDW standards	• Unknown
69) Majette Towers Landfill, Florida (1)	32	A	GW,SW?	• On-site GW exhibits elevated levels of heavy metals • Site located in wetland and discharges to lake - no damages documented	• Surface runoff treated before disposal • Under litigation

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
70) United Sanitation Services Sanitary Landfill, Florida (1)	32	A	GW,SW	• On-site GW exhibits elevated levels of Fe, TDS exceeding NSDW standards • Off-site GW exhibits elevated levels of NH_3, TDS, and conductivity • SW discharge exceeds effluent standards for BOD, phenols, total coliform, and fecal coliform	• Additional monitoring • Installation of runoff controls
71) Short Mountain Sanitary Landfill, Oregon (1)	11	A	GW	• On-site GW exhibits elevated levels of organics, COD, and TOC; Cl and SO_4 exceed NSDW standards	• Improve LCS
72) Woodburn Sanitary Landfill, Oregon (1)	13	A	GW	• On-site GW exhibits elevated levels of COD, TOC, and color; Cl and Fe exceed NSDW standards	• Improve leachate management and site drainage

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
73) County Line Landfill, Colorado (3b)	8	A	GW	• On-site GW exhibits: - trichloroethylene - tetrachloroethylene - 1,2-trans-dichloroethylene - benzene exceeding MCLs • Ethylbenzene, methylene chloride, and toluene also detected	• GW pumped and treated
74) Combe Fill North Landfill, New Jersey (6)	1966-1981	C	GW	• On-site GW exhibited elevated levels of hexachlorobenzene, phenol, and bis (2-ethylhexyl) phthalate	• NPL site • Site ordered closed • Regrade and cover and install perimeter drainage system
75) Lowry Landfill, Colorado (3b)	-	-	GW,SW	• Surface water and upper aquifer contaminated	• Barrier wall and pump and treat
76) Norris Farm Landfill, Maryland (3e)	1960's?-1985	C	GW,SW?	• On-site GW extensively contaminated • GW discharged to adjacent tidal basin - no impacts documented	• Slurry wall and leachate collection • Site ordered closed
77) Pickettville Road Landfill, Florida (3c)	1940's-1977	C	SW	• Off-site SW contaminated with priority pollutant metals (Fe, Cr, Cu, Pb)	• NPL site - under investigation

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
78) Pagossa Springs Landfill, Colorado (3b)	-	C	SW	• SW contaminated	• Site closed • Run-off collected
79) Van Dahl Landfill, Colorado (1) (3b)	1982-Present	A	SW	• Adjacent SW (creek) contaminated	• Under investigation
80) Red Hill Disposal Si.e, California (8)	1975-Present	A	SW,GW	• Local contamination of adjacent creek • On-site GW exhibits elevated levels of Cl, alkalinity, and TDS	• Closure of one area of site • Cut-off dam and drain constructed
81) Brookings Landfill, South Dakota (4)	-	-	GW	• On-site GW contaminated	• GW Intercepter trench installed
82) Landfill, Central Pennsylvania (4)	1969-?	-	GW,SW	• On-site GW contaminated • Nearby SW contaminated by discharge from on-site contaminated spring	• Contaminated spring collected and treated via evaporation • SW diverted
83) Landfill, Macomb, Illinois (4)	?-1971	C	SW	• SW contaminated by leachate seeps from buried spring	• Site regraded
84) Landfill, Palos Hill, Illinois (4)	?-1973	C	GW	• On-site GW contaminated (extent unknown)	• Divert SW • Install liner • Site ordered closed • Continue GW monitoring
85) Landfill, South Belort, Illinois (4)	1947-1976	C	GW	• On-site and off-site GW contaminated	• Site closed • GW monitored

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
86) Olin Avenue Sanitary Landfill, Wisconsin (4)	-	-	GW,SW	• Off-site and on-site SW and GW contaminated • Located in former marsh • Site has changed nature of area	• None
87) Landfill, South-eastern Pennsylvania (4)	1960's-?	-	SW,GW	• On-site GW and SW contaminated by discharges from leachate springs	• Liner and LCS (partial) installed
88) Ridgeview Regional Landfill, Wisconsin (1)	17	A	GW	• On-site GW contamination	• Old areas closed • New areas lined and LCS installed
89) Dane County Verona Landfill, Wisconsin (1)	10	A	GW	• On-site GW exhibits elevated levels of VOCs	• Additional monitoring
90) Chattahoochee Landfill, Florida (1)	5	A	SW	• Off-site SW contaminated from discharges from site	• Site ordered closed
91) Sunset Farms Landfill, Texas (1)			GW	• On-site GW exhibits elevated levels of TDS and Cl exceeding NSDW standards	• None
92) Brushy Island II Sanitary Landfill, Arkansas (1)	-	-	GW	• On-site GW exhibits elevated levels of Mn, SO_4, Fe, and Cl exceeding NSDW standard	• None

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
93) Benton Sanitary Landfill, Arkansas (1)	-	-	GW	• On-site GW exhibits elevated levels of COD and BOD; Pb exceeds MCL and Mn exceeds NSDW standards	• None
94) Van Buren Sanitary Landfill, Arkansas (1)	-	-	GW	• On-site GW exhibits elevated level of COD; Mn, Fe exceed NSDW standard	• None
95) Franklin County Sanitary Landfill, Florida (1)	7	-	GW	• On-site GW exhibits elevated levels of COD and TS	• Under litigation
96) Broward County Landfill, Florida (1)	23	A	GW	• On-site GW contaminated from landfill leachate and from sludge lagoon	• NPL • Site to close in 1989
97) Jackson East Sanitary Landfill, Florida (1)	-	-	GW	• On-site GW exhibits elevated levels of Cd, Cr exceeding MCL and Fe, Mn exceeding NSDW standards	• Site closed
98) Perdido MSW Site, Florida (3c)	6	A	GW	• On-site GW exhibits contamination	• New monitoring system
99) Roseburg Central Landfill, Oregon (1)	>40	A	GW,SW	• On-site GW contaminated • Instances of SW contamination noted	• Unknown

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
100) South Stage Disposal Site, Oregon (1)	25	A	SW	• Discharges of leachate to SW observed	• None
101) Dry Creek Disposal Site, Oregon (1)	15	A	SW	• Instances of SW contamination documented	• None
102) St. John's Landfill, Oregon (1)	45	A	GW	• On-site GW exhibits elevated levels of Cl, Fe, Mn exceeding NSDW standards	• None - site on island
103) Agate Beach Landfill, Oregon (1)	-	-	GW?	• Potential off-site GW contamination	• Interceptor trench improved
104) KFD/Reidel Landfill, Oregon (1)	-	A	GW	• On-site GW exhibits elevated levels of COD and Fe	• None
105) Russellville Landfill, Arkansas (3a)	-	-	GW	• On-site GW exhibits elevated levels of contaminants	• None
106) El Dorado Landfill, Arkansas (3a)	-	-	GW	• On-site GW exhibits elevated levels of contaminants	• None
107) Batesville Landfill, Arkansas (3a)	-	-	GW	• On-site GW exhibits elevated levels of contaminants	• None
108) Magnolia Landfill, Arkansas (3a)	-	-	GW	• On-site GW exhibits elevated levels of contaminants	• None

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
109) Searcy Landfill, Arkansas (3a)	-	-	GW	• On-site GW exhibits elevated levels of contaminants	• None
110) Tollgate Landfill, Maryland (3e)	-	A	GW	• On-site GW contaminated	• Under investigation • Site closure with synthetic cap ordered
111) Dallas Linfield Road Site, Texas (3d)	1957-1965	C	GW	• On-site GW exhibits elevated levels of NO_4, Mn, and As	• Under investigation
112) Browning Ferris Industries, Montana (3f)	25	-	GW	• On-site GW exhibits elevated levels of As, Fe, Cl, and indicator parameters	• Under investigation
113) Cloyds Mountain Landfill, Virginia (3g)	1983-Present	A	SW	• Leachate flows off-site to SW	• Site ordered to close in 1989 and apply for NPDES permit
114) Landfill, Riverside, California (4)	1948-?	-	GW	• GW contamination extends one mile from site	• Unknown
115) Landfill, Elgin, Illinois (4)	1968-?	-	GW	• On-site GW contaminated	• Unknown
116) Woodstock Landfill, Illinois (4)	1940-?	-	GW	• On-site GW contaminated • Refuse placed in swamp	• None
117) Winnetka Landfill, Illinois (4)	1947-?	-	GW	• On-site GW contaminated	• None

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
118) Landfill, South Elgin, Illinois (4)	late 60's-70's	-	GW	• On-site GW contaminated posing threat to community well field	• Site regraded and closed
119) Landfill, Springfield, Illinois (4)	1970's?	C	GW	• On-site GW contaminated	• Site closed
120) Landfill, Monore Co., Michigan (4)	-	-	GW	• On-site GW contaminated	• Unknown
121) Landfill, Southern Connecticut (4)	~30	C	GW,SW	• GW and SW contaminated • GW plume approx. 3500 ft by 3000 ft by 60 ft • Waste placed in wetlands (90 acres)	• Site closed and capped
122) Landfill, Ames, Iowa (4)	1954?-1972?	-	GW	• GW contaminated 7000 ft from site and between 80 and 100 ft deep	• Unknown
123) Omaha Landfill, Iowa (4)	1963?-1972?	-	GW	• GW contaminated in a zone 5100 ft wide, 670 ft long, and 40 ft deep	• Unknown
124) Torne Valley RDA, New York (2)	15	A	SW,GW	• SW, GW contaminated with metals, phenols, chlorides, ammonia, and VOCs • Suspected impacts to off-site drinking water, flora and fauna	• Expanded monitoring to characterize extent of contamination

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
125) Merril Field Sanitary Landfill, Alaska (2)	45	A	GW	• On-site GW contaminated with metals, phenols and VOCs	• Monitoring of leachate plume
126) Denver-Arapaho Disposal Site, Colorado (2)	21	A	GW,SW?	• On-site GW contaminated with VOCs, phenols and pesticides • Suspected SW contamination by similar constituents	• Extensive GW monitoring
127) Lake Charles Landfill, Louisiana (2)	-	A	SW,GW?	• On-site SW contaminated with methylene chloride, ketones and chloroform • Suspected GW contamination	• Further site investigations
128) Eastside Colby Landfill, Oklahoma (2)	-	C	GW	• On-site GW contaminated with lead, arsenic, mercury, VOCs, and phthalates	• Installation of monitoring wells to characterize extent of plume
129) Crittenden County Landfill, Arkansas (2)	-	A	GW,SW?	• On-site GW contaminated with phthalates and methylene chloride • Suspected SW contamination	• Further site investigations and characterizations

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
130) Stark County/Breitestine Landfill, Ohio (2)	11	A	SW,GW	• On-site SW and GW contaminated with chromium, lead, mercury metals and dissolved solids	• Installation of monitoring wells • SW sampling program
131) Saco Landfill, Maine (2)	1960-1974 (inactive units) 1974-Present (active units)	A	SW,GW	• On-site SW contaminated with metals, phthalates and ethers • On-site GW contaminated with toluene and MEK	• SW,GW and leachate sampling and monitoring program established • Measures taken to limit leachate production
132) Old Ticonderoga Landfill, New York (2)	-	C	SW,GW	• On-site SW and GW contaminated by spills and leaks that contained PCBs and metals	• Expanded monitoring to characterize extent of contamination
133) Glen Falls Landfill, New York (2)	?-1978	C	SW,GW	• On-site SW and GW contaminated with PCBs	• Extended sampling and monitoring program
134) Greenwich Landfill, New York (2)	-	A	GW	• On-site GW contaminated with PCBs and metals	• Site inspection and further evaluation
135) Colonie Sanitary Landfill, New York (2)	78	A	SW,GW	• On-site SW and GW contaminated with VOCs, phenols and asbestos • Leachate flows towards SW	• Installation of monitoring wells • Ground-water sampling program • Periodic inspections of the site

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
136) International Airport Road Sanitary Landfill, Alaska (2)	1950-1977	C	GW	• On-site GW contaminated with arsenic and selenium	• None
137) Colbert Landfill, Washington (2)	-	A	GW	• On-site GW contamination with VOCs	• None
138) Douglas County Sanitary Landfill, Nevada (2)	-	A	GW	• On-site GW contaminated with metals	• None
139) Hugo Waste Disposal Site Landfill, Oklahoma (2)	-	A	SW,GW	• On-site SW and GW contaminated with phthalates, methylene chloride, arsenic, barium and fluorides	• None
140) Bedford County Landfill, Tennessee (2)	17	A	GW	• On-site GW contaminated with lead	• None
141) Biggs Landfill, Tennessee (2)	-	A	SW	• On-site SW contaminated with zinc, pesticides, cyanide and hexachlorocyclo-pentadiene	• None
142) Oswald Landfill, Pennsylvania (2)	1952-1978	C	GW	• On-site GW contaminated with vinyl chloride, benzene and lead	• None

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
143) South Charleston Municipal Landfill, West Virginia (2)	-	A	SW,GW	• On-site SW and GW contaminated with lead, metals, VOCs, and pesticides	• None
144) Bell Sanitary Landfill Terry TWP, Pennsylvania (2)	12	A	SW,GW	• On-site SW and GW contaminated with TCE, arsenic, phenol, pesticides, and bis (2-ethylhexyl) phthatales	• None
145) Kesselring Site Sanitary Landfill, New York (2)	-	A	GW	• On-site GW contaminated with chlorides, irons, nitrogen, suspended solids, and organic carbon	• None
146) Lone Pine Corp. SWDA, New Jersey (2)	-	A	GW, SW?	• On-site GW contaminated with chlorobenzene, phenols, pesticides, methylene chloride, chloroform, metals, and VOCs • Suspected SW contamination	• None
147) Niagara Sanitary Landfill, New York (2)	19	-	SW,GW	• On-site SW and GW contaminated with VOCs, PCBs, metals, dyes, and radionuclides	• None

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
148) Oswego Valley Sanitary Landfill, New York (2)	19	A	GW	• On-site GW contaminated with toluene and bromodichloromethane • Suspected SW contamination	• None
149) Wallkill Landfill, New York (2)	-	C	SW,GW	• On-site SW and GW contaminated with zinc and dichloromethylene	• None
150) Waste Disposal Inc., New Jersey (2)	-	A	SW	• On-site SW contaminated with trichloroethane, toluene, and trichlorobenzene	• None
151) Penaluna Landfill, New York (2)	-	C	GW	• On-site GW contaminated with toluene and bis- (2-ethylhexyl) phthalate	• None
152) Sanitary Landfill, Rhode Island (2)	1944-Present	-	SW,GW	• On-site SW and GW contaminated with VOCs and metals	• None
153) Babylon Landfill, New York (2)	32	A	GW	• On-site GW contaminated with dissolved solids, chlorides, metals, and ammonia	• None
154) Hauppauge Landfill, New York (2)	32	A	GW	• On-site GW contaminated with inorganics, dissolved solids, and VOCs	• None

* Age at time of report or data acquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
155) Cheltingham Avenue Landfill, New York (2)	22	A	SW	• On-site SW contaminated with chlorides and metals	• None
156) Bethpage Sanitary Landfill, New York (2)	19	A	SW?,GW	• Suspected on-site SW and GW contaminated with ethyl ketone, trichloroethylene and toluene	• None
157) Montgomery County Landfill, New York (2)	-	A	GW	• On-site GW contaminated with metals (mercury) and phenols	• None
158) Sanitary Landfill, Inc., Town of Johnstown, New York (2)	35	A	GW	• On-site GW contaminated with arsenic and VOCs	• None
159) Brown's Island Landfill, Oregon (1)	20	C	GW,SW?	• GW degradation in on-site and off-site wells • Elevated levels of COD, TOC and dissolved organics • Plume discharges to Willamette River where it is diluted to baseline levels	• Site scheduled for closure in 1986

* Age at time of report or data aquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
160) Brown County East Sanitary Landfill, Wisconsin (1)	11	A	GW	• Resistivity surveys show a gradual increase in ionic strength of GW with time • Conductivity and hardness in several on-site wells also increased • Overall impact to on-site GW quality "believed to be minor"	• Modifications to clay liner and leachate collection system
161) Wilton Landfill, Connecticut (1)	1966-1976	C	SW,GW	• GW and SW both contaminated with high TDS, Cl, organics, metals, and pH • One off-site well closed due to contamination • Several wetlands within and adjacent to site	• Landfill ordered to close • SW and GW continue to be monitored • One well closed • Other wells must be remediated, if necessary
162) Tork Sanitary Landfill, Seneca Site, Wisconsin (1)	1960-1982 (old) after 1985 (new)	A,C	GW	• Original landfill SE of site has contaminated GW and is scheduled to close in 1982	• None

* Age at time of report or data aquisition.

TABLE 1
HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM MSWLFs (continued)

Site	Operating Dates or Age*	Status	Media Impacted	Description of Impacts	Corrective Action
163) Winnebago County Sanitary Landfill, Wisconsin (1)	16	A	GW	• On-site wells show elevated levels • Cl in on-site wells exceeds National Secondary Drinking Water Standards • Ambiguous evidence for off-site GW contamination	• Actions taken to improve leachate collection system

* Age at time of report or data aquisition.

TABLE 2
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN, AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
1) West Bend Sanitary Landfill (1) Wisconsin	Documented (D)		• Soil: glacial deposits of clay, silt, sant, gravel, and boulders (variable permeability) • Depth to GW: 11-96 ft • Ponded water • P = 30"	• No liner • No LCS	• Shallow GW • Variable permeability of soils • No liner • No LCS • Ponded water
2) Delafield Sanitary Landfill (1) Wisconsin	D		• Soil: sand, gravel, glacial till and silty clays (permeability of $8x10^{-4}$ - $1x10^{-3}$ cm/sec) • Depth to usable GW: 30-50 ft • P = 30"	• First liner installed improperly • Prior to 1975 no liner • 13.5 out of 38 acres are lined • LCS installed in 1978 • Runoff controls • Parts of the old site in GW	• Permeable soils • Shallow GW • No liners (initially) • Parts of the old site in GW • No LCS (initially)
3) Black River Falls Landfill (1) Wisconsin	D		• Soils: highly permeable • Depth to GW: 15-53 ft • P = 30"	• No liner • No LCS • Inadequate final cover material: sand • No drainage of the final cover	• Highly permeable soil • Shallow GW • No liner • No LCS • Inadequate final cover • Inadequate drainage

TABLE 2
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN, AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
4) Carroll County Sanitary Landfill (1) Arkansas	Suspected (S)	D	• Soils: mixture of gravelly peat underlain by clay with permeability varying from 10^{-2} to 10^{-7} cm/sec • Shallow GW (a source of potable water) • P = 45"	• No liner • No LCS • Inadequate drainage controls • No GW monitoring	• Soil of variable permeability • Shallow GW • High P • Inadequate drainage controls • No liner • No LCS
5) Litchfield Landfill (1) Connecticut	D	S	• Soil: 5 ft of glacial till over weathered bedrock (low permeability) • Poor natural drainage • High GW table • P = 43"	• Inadequate cover • No liner • No LCS • GW monitoring system since 1982	• High GW table • High P • No liner • Inadequate cover • Poor drainage • No LCS
6) Sauk County Solid Waste Management Site (1) Wisconsin	D		• Soils: fine sand over sandstone and shale bedrock • Depth to GW: 40-60 ft • P = 32"	• No liners • No LCS • Runoff controls	• No liner • No LCS
7) Tolland Landfill (1) Connecticut	D		• Soil: 10 ft thick glacial till over fractured bedrock • Till less than 3 ft thick when operations began • P = 45"	• No liners • No LCS • Restricted drainage • No GW monitoring • Poor management	• No liners • Site geology • No LCS • Poor management procedures • High P

TABLE 2
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN, AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
8) South Windsor Landfill (1) Connecticut	D	D	• Soils: highly permeable over a thick layer of clay • Near or in wetlands • Shallow GW • P = 45"	• No liner • No LCS • Inadequate runoff controls • SW monitoring • GW monitoring	• Highly permeable soil • Shallow GW • High P • No liner • No LCS • Inadaquate runoff controls • Located near or in wetland
9) Canton Landfill (1) Connecticut	D	D	• Soils: permeable glacial drift • 2 aquifers below • P = 44"	• Past hazardous waste disposal • No daily cover (initially) • No liner • No LCS • Poor grading • Inadequate present cover • GW monitoring since 1980 • Inadequate drainage control	• Highly permeable soils • No liner • Inadequate present cover • No LCS • High P • Inadequate drainage controls • Past hazardous waste disposal
10) Lena Road Landfill (1) Florida	D	D	• Soil: 10-20 ft silty sand over a 300 ft stratum of clay, fine sand and silts • Depth to GW: 2-5 ft • 3 aquifers below • P = 50"	• LCS (installed in 1983: 15 years after the startup) • Slurry wall around to control GW contamination • Runon/runoff control system (since 1985) • No liner • Inadequate cover	• Shallow GW • Inadequate cover • High P • No liner • No LCS (initially) • No runon/runoff controls (initially)

TABLE 2
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN, AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
11) Northwest 58th Street Landfill (1) Florida	D		• Soil: highly permeable • Shallow GW, (important aquifer) • P = 60"	• Wastes placed below the GW table • Inadequate cover • No liner • No LCS	• Highly permeable soil • Waste below GW table • High P • Shallow GW • No liner • No LCS • Inadequate cover
12) Lantana Road Sanitary Landfill (1) Florida	D		• Soil: gray and tan sand and sandstone cavity riddled • Shallow GW • P = 64"	• No liners • No LCS • Surface drainage discharges to a lake • GW monitoring	• Shallow GW • Permeable soils • No liner • No LCS • Surface drainage discharge to a lake • High P
13) Hillsborough Heights Sanitary Landfill (1) Florida	D		• Karst topography • Depth to GW: 18-22 ft • Variable thickness of soils and underlying clays • P = 50"	• LCS • Runoff controls • GW monitoring • Liners	• Karst topography • High P • Problem may have been caused by previously active parts of the landfill not equipped with any environmental controls

TABLE 2
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN, AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
14) Tillamook County Landfill (1) Oregon	D	D	• Soil: Silty sand and sandy silts • Depth to GW: 9.5-11.5 ft • P = 100"	• Originally no liner • Present liner: a mixture of native soil and bentonite • LCS since 1979 • Inadequate daily cover • GW monitoring • SW monitoring • Runon/runoff controls	• No liner (initially) • Inadequate daily cover • Shallow GW • High P • No LCS (initially) • Inadequate liner present
15) Rossman's Landfill (1) Oregon	D		• Clayey silt • Depth to GW: 15-25 ft • P = 50"	• Natural clay liner • Runoff/runon control system • No LCS • Inadequate final cover	• Shallow GW • Inadequate runoff/runon control system • High P • Inadequate final cover • No LCS
18) Fox Valley Solid Waste Disposal Site (13) Illinois	D		• Soil: thin layer of soil over a creviced bedrock aquifer • Determined to be unsuitable for landfilling • P = 36"	• The thin layer of soil stripped away at the beginning of operations • No cover • No LCS • No liner	• A layer of [illegible] stripped away • No cover • No LCS • No liner
56) Lauer 1 Sanitary Landfill (1) Wisconsin	D	D	• Soil: permeable sand • Depth to GW: 10 ft • P = 32"	• No liners (initially) • No LCS • Inadequate runon/runoff control system • Liquid and industrial wastes codisposal	• Permeable soil • Shallow GW • No liners (initially) • No LCS • Inadequate runon/runoff controls • Liquid and industrial waste codisposal

TABLE 2
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN, AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
57) Coffin Butte Sanitary Landfill (1) Oregon		D	• Soil: low permeability clays • Depth to GW: 32-50 ft • P = 40"	• Inadequate LCS • No liner • No runoff/runon control system • Daily cover	• High P • Inadequate LCS • No liner • No runon/runoff controls system
58) Grants Pass Landfill (1) Oregon	D		• Soil: 4 inches of sandy loam and loam - very porous • Decomposed granite underneath • Depth to GW: 30-50 ft • P = 40"	• No liners • Inadequate LCS • Inadequate runoff controls • 1 monitoring well (maybe 2)	• Very porous soil • High P • No liners • Inadequate LCS • Inadequate runoff control system
Jonesboro Sanitary* Landfill (1) Arkansas	D		• Highly permeable soil • P = 48"	• Areas without liner • Past hazardous waste disposal • Areas with 12 inch thick clay liner • No drainage controls • No GW monitoring • No LCS	• Permeable soils • Past hazardous waste disposal • Areas without liner • No drainage controls • No LCS • High P

* not included in Table 1 because site accepted large amounts of hazardous waste

TABLE 2
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN, AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
59) South Canyon Landfill (1) Colorado		D	• Soil: silty sands and silty clay • Depth to GW: 3-22 ft • P = 24" • Deep aquifer: 100 ft	• LCS • Past hazardous waste disposal • No liners • Inadequate daily cover • Inadequate runon/runoff control system	• Shallow GW • Past hazardous waste disposal • Inadequate runon/runoff control system • Inadequate daily cover • No liner
60) Fort Collins - Loveland Sanitary Landfill (1) Colorado	D	D	• Soil: topsoil on weathered shale underlain by solid shale • Perched water • Shallow GW • P = 14"	• Waste buried close to the GW table • No LCS • No liner • No runon/runoff control system • GW and SW monitoring	• Shallow GW • Waste buried close to the GW table • No LCS • No liner • No runon/runoff control system
62) Gainesville Landfill (1) Texas	D		• Soils: sands, sandy clays, clays • Depth to GW: 6-22 ft • Presently landfill area underlain by sand • P = 30"	• Daily cover • GW monitoring • GW quality violations • No liner (most cells) • No LCS	• Permeable sand • Shallow GW • No liner • No LCS • Poor operation procedures

TABLE 2
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN, AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
Atascocita Landfill* (1) Texas	D		• Soil: clays with interbedded silts and sand • Located over 3 aquifers • Depth to GW: 22-26 ft • P = 44" • GW hydrostatic pressure	• Trenches in GW • Runoff system • Natural clay and no liners • LCS since 1983 • Daily cover • GW monitoring	• Variable soil permeability • Shallow GW • GW hydrostatic pressure • High P • Trenches in GW • No LCS (initially) • Inadequate environmental controls • No liners (partial)
63) Pearsall Road Landfill (1) Texas	D		• Soil: impervious formations 500 ft thick above an aquifer • Shallow GW • SW drains into a creek • P = 28"	• Inadequate liner • GW monitoring • No runoff controls	• Shallow GW • Inadequate liner • No runoff controls • Runoff drains into a creek
64) DFW Landfill (1) Texas	D		• Soil: clays and silts • Permeable sand & gravel above the bedrock • Located in floodplain • P = 58"	• Clay liner • LCS • GW monitoring • Runon/runoff controls	• Located in floodplain • Improperly designed environmental controls (suspected) • High P
65) Shelton Landfill (1) Connecticut	D	S	• Soils: thick sand and gravel deposits • P = 41"	• No liner • No LCS • Drainage system	• High P • No liner • No LCS

*Site not included in Table 1 because site accepted waste oils and oil sludges.

TABLE 2
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN, AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
66) Hartford Landfill (1) Connecticut	D	S	• Located in floodplain • Permeable soils • P = 44	• No liners • No LCS • GW monitoring • Inadequate runoff controls • Inadequate natural drainage	• Permeable soils • Located in floodplain • High P • No liners • No LCS • Inadequate runoff controls or natural drainage
67) Cleburne County (L&H) Landfill (1) Arkansas	D		• Moderately impermeable soils • Depth to GW: 20-30 ft • Perched water: 4-16 ft below • Sections located in floodplain • precipitation (P) = 48" annual	• 1.5 ft of sandy clay at the bottom • No Leachate Collection System (LCS) • Inadequate cover • 3 GW monitoring wells • Inadequate liner	• Inadequate liner • High P • No LCS • Inadquate cover •Shallow GW • Location in floodplain
68) Central Disposal Sanitary Landfill (1) Florida	D		• Soil: highly permeable limestones • Surface water; lakes and canals (localized) • P = 60"	• Wastes placed below the GW table prior to 1970 • No liner • LC pond • No runoff control system	• Highly permeable soils • High P • No liner • No runoff control system • Wastes below GW table
69) Majette Towers Landfill (1) Florida	D	S	• Soil: sands • Located over important aquifer • P = 60"	• No liner (initially) • Partial LCS • Present liner is a cap on the old cells	• Permeable soils • No liner (initially) • Partial LCS • High P

TABLE 2
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN, AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
Dyer Boulevard Sanitary Landfill* (1) Florida	D	D	•Soils: sandy • Depth to GW: 100-150 ft • Ponding on site • SW • P = 60"	• No liners, LCS and runoff controls, or cover at the old section • Liner, LCS, runoff controls and daily cover at the new section	• Permeable soils • SW ponding on site • No liners, LCS, runoff controls cover at old section
70) United Sanitation Services Sanitary Landfill (1) Florida	D	D	• Depth to seasonal GW: 2 ft • P = 60"	• Portions of the older landfill below the GW table • No liners at the old landfill • New site has soil liners, runoff controls, GW monitoring program, and daily cover	• Shallow GW • High P •No environmental controls at the old closed site • Inadequate liner at the new portion (suspected) • Waste below GW table
71) Short Mountain Sanitary Landfill (1) Oregon	D		• Located in floodplain • Underlain by clay, mudstone, etc. with low permeability • Depth to GW: 5-12 ft • P = 40"	• Natural liner (trenches 3 ft above the seasonal water table) • GW and SW monitoring • Daily cover • LCS	• Located in floodplain • Shallow GW • Inadequate liner • High P
72) Woodburn Sanitary Landfill (1) Oregon	D		• Soil: low permeability clay • Perched water • Depth to GW: 2 to 20 ft • P = 40"	• Natural liner • Inadequate LCS • Inadequate GW monitoring	• Inadequate LCS • High P • Liner inadequate (suspected)

*Site not included in Table 1 because site accepted large amounts of hazardous waste.

TABLE 2
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN, AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
73) County Line Landfill (1) Colorado	D		• Geology highly variable • 3 aquifers below (shallow GW) • P = 17"	• No liner • Natural drainage impeded • Daily cover • No LCS	• Variable geology • Shallow GW • No liner • No LCS
79) Van-Dal Landfill (1) Colorado		D	• Site intermittently covered with SW • Soil: weathered shale covered with slope-wash deposited soils and residual clays • No GW in the shale bedrock • P = 19"	• No liners • Inadequate runoff control system • No SW monitoring • No LCS	• SW covering the site (intermittently) • Inadequate runoff control system • No liners • No LCS
88) Ridgeview Regional Landfill (1) Wisconsin	D		• Located in wetlands • Soil of variable permeability • Depth to GW: 50 ft • P = 30"	• Consists of old and new sites • No information on the old site design and operation • The new site is a state-of-the-art expansion	• Variable soil permeability • Located in wetlands • No environmental controls at the old site (suspected)
89) Dane County Verona Landfill (1) Wisconsin	D		• Soil: fine sandy silt and clay (permeability of 10^{-7} - 10^{-8} cm/sec) • 2 important aquifers at site • Depth to GW: 20-40 ft • P = 30"	• 2 ft thick clay liner • Runon/runoff controls • LCS (installed a few years after startup) • Daily cover • 2 GW monitoring wells	• Important aquifers at site • Inadequate liner (installed late) • Inadequate LCS

TABLE 2
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES (continued)

SITE	DAMAGES GW	DAMAGES SW	ENVIRONMENTAL SETTING	WASTE, DESIGN, AND OPERATION CHARACTERISTICS	LINKAGE
90) Chattahoochee Landfill (1) Florida		D	• Soil: sandy clay • Depth to GW: 12 ft • P = 56"	• No daily cover • 2 ft thick clay liner • Inadequate runon/runoff control system	• No daily cover • Inadequate runon/runoff control system • Shallow GW • High P
95) Franklin County Sanitary Landfill (1) Florida	D		• Soil: sands with permeability of $1x10^{-4}$ to $1x10^{-2}$ cm/sec • Depth to GW: 2 ft • Free standing water at places • P = 64"	• LCS (installed in 1984) • No liner • No daily cover before 1984 • Storm water diversion system	• Permeable soil • Shallow GW • No liner • Inadequate LCS • No daily cover before 1984 • High P • SW ponding
96) Broward County Landfill (1) Florida	D		• Depth to GW: 2-4 ft below the original ground surface • P = 60"	• Asphalt liners • LCS, drainage control, daily cover and GW monitoring system for a new cell • Unlined lagoon 25 ft below the GW table • No runoff controls, liner, daily cover and LCS at the old part	• Shallow GW • High P • No runoff controls, liner, daily cover, and LCS at the old section • Unlined lagoon below GW table
98) Perdido Municipal Solid Waste Site (1) Florida	D		• Soil: silty clays with permeability of 10^{-7} cm/sec • P = 67"	• Natural clay liner • LCS • Runoff controls • Final cover	• High P • Data inconclusive: landfill environmental controls suspected to be inadequate

TABLE 2
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN, AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
99) Roseburg Central Landfill (1) Oregon	D	D	• Soil: weathered submarine basalts interbedded sediments and clay • P = 40"	• Inadequate LCS • Daily cover • 2 GW monitoring wells • SW monitoring • No liner (suspected)	• Inadequate LCS • No liner (suspected) • High P
100) South Stage Disposal Site (1) Oregon		D	• Soils: clay and shale • Depth to static GW: 25 ft • Bedrock: sandstone and basalt interbedded with claystone • P = 32"	• No LCS • No liner • No GW monitoring • Leachate discharge to surface drainage system • Inadequate runon/runoff controls • Inadequate daily cover • Possible leachate discharge to GW	• Inadequate runon/runoff controls • Inadequate daily cover • Shallow GW • No liner • No LCS
101) Dry Creek Disposal Site (1) Oregon		D	• Highly weathered pyroclastic rock below a 5-15 ft layer of clay and sandy clay • Depth to GW: 30 ft • P = 32"	• No liner • No GW monitoring • Runon controls • Poor operation practices • Damaged SW diversion ditches • No LCS • Inadequate cover • Leachate discharging into SW	• Site geology • Damaged SW diversion ditches • Inadequate cover • Leachate discharging into SW • No liner

TABLE 2
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN, AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
102) St. Johns Landfill (1) Oregon	D		• Located in wetlands and floodplain • Adjacent to lake • Soil: clayey silt, silt, sandy silt and gravel • Major aquifer below • P = 40"	• No runoff controls • LCS on the expansion area • No LCS in original area • No liner • Daily cover • GW monitoring system	• Located in wetland and floodplain • High P • No liner • No LCS in original area • No runoff controls
104) KFD/Riedel Landfill (1) Oregon	D		• Soils: 50 ft of medium sand and silt on layers of sands and gravels • Depth to GW: 20-40 ft • P = 40"	• Compacted clay bottom liners and synthetic side liners • GW monitoring • Inadequate LCS • Inadequate cover (suspected) • No runon/runoff control system (suspected)	• Inadequate LCS • Inadequate cover (suspected) • High P • No runon/runoff control system (suspected)
159) Brown's Island Landfill (1) Oregon	D	S	• Located in floodplain • Moderately to highly permeable soil • Depth to GW: 10 to 20 ft • P = 41"	• Natural liner: 5 ft of moderate permeability soil • No LCS • Final cover • No runon/runoff control system	• Shallow GW • Permeable soils • High P • Inadequate natural liner • No LCS • Location in floodplain • No runon/runoff control system

TABLE 2
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN, AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
160) Brown County East Sanitary Landfill (1) Wisconsin	D		• Soil: sand, gravel and clay • Shallow GW • P = 30"	• Inadequate clay liner • Inadequate LCS • Runoff controls • Daily cover • GW monitoring system	• Shallow GW • Inadequate liner • Inadequate LCS
161) Wilton Landfill (1) Connecticut	D	D	• Located in wetland • Soil: metamorphic bedrock overlain by a glacial till of clayey to clayey fine sandy loam • GW in bedrock and glacial till • P = 42"	• No liner • No LCS (initially) • Runon/runoff control system • GW monitoring	• Located in wetland • Shallow GW • High P • No liner • No LCS (initially)
162) Tork Sanitary Landfill, Seneca Site (1) Wisconsin	D		• Soil: shallow crystalline bedrock covered with silty and sandy loams • Depth to GW: 1-3 ft • Wetlands nearby • P = 32"	• The new part has adequate environmental controls	• The old site did not have environmental controls (suspected) • Shallow seasonal GW • Located near wetlands
163) Winnebago County Sanitary Landfill (1) Wisconsin	D		• Soil: silty clay underlain by sandy silt and sitly sand • Highly permeable sands and gravels at places • P = 30"	• Some trenches below the GW table • No liners (initially) • Liners in newer cells • GW monitoring since 1975 • SW runoff controls • Leachate monitoring • Improper operation of LCS	• Permeable sands and gravels • Improper operation of LCS • No liners (initially) • Trenches below GW table

TABLE 3
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES - ADDITIONAL FACILITIES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
33) Charles George Reclamation Trust, Tyingsborough, MA (2)	Documented (D)		• Depth to GW: 5-20 ft • Landfill drainage and leachate run through private properties	• Some liquids and past hazardous waste disposal of • No runoff control system • No LCS • No liner	• Shallow GW • No liner • No LCS • Inadequate drainage • No runoff control system • Past hazardous waste disposal
34) Sidney Landfill, Sidney, New York (2)	D	D	• Adjacent to floodplains and wetlands (ponds, dammed up pools and swampy areas 0.5 mile away) • GW 10 to 12 ft below	• Waste oils and metals buried in 1966 • Drainage goes into the watershed of the Sidney Center Water Supply	• Shallow GW • Disposal of metals • Adjacent to floodplains, wetlands • No environmental controls • Inadequate drainage controls
35) Site T, Region VII Iowa (2)	Suspected (S)	D	• Soils: glacial till overlain by a loess mantle with permeability of 10^{-7} - 10^{-9} cm/sec • GW 5 to 15 ft deep • Runoff drains into a creek, a tributary of the Mississippi River • Leachate expected to migrate into SW	• Municipal and industrial wastes codisposed • Poor operation practices • Sawdust as a cover material (inadequate) • No GW monitoring wells • No runon/ runoff control system	• Shallow GW • No environmental controls • Hazardous waste co-disposal • Poor operations practices • Inadequate cover • No runon/runoff control system

TABLE 3
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES - ADDITIONAL FACILITIES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
36) Huntington TWP Landfill, Huntington TWP, New York (2)	D		• Soil: sands, highly permeable • Far from any surface water bodies	• 7 GW monitoring wells • Inadequate environmental controls	• Permeable soils • No environmental controls
37) Dover Municipal Landfill, Dover, New Hamsphire (2)	D	D	• Soils: sandy plain with boulders or bedrock outcrop • Leachate release around the landfill	• Prior to 1980, accepted hazardous wastes • Sludges and liquids codisposed • No liner • No LCS	• Permeable soil • No liner • No LCS • Past hazardous waste disposal
38) Holden Town Dump, Holden, MA (2)	D	D	• Contaminated plume flows into the tributary of a reservoir - the major water supply for the Metropolitan Boston area	• Hazardous wastes disposal	• LIAS
39) Pemberton TWP Landfill, Pemberton, New Jersey (2)	D		• Sited over the Cohansey Aquifer	• Some waste other than municipal are accepted • 2 GW monitoring wells	LIAS
40) Landfill and Development Co., Mount Holly, New Jersey (2)	D		• Previously a sand and gravel pit • Near floodplain • Located directly on top of 2 potable aquifers • Leachate streams on site • Leachate discharge to the SW	• Inadequate runon/runoff control system • Synthetic liner in some areas • Final cover in some areas • GW monitoring system	• Permeable soil • Inadequate runon/runoff controls • Inadequate cover • No liner (in some areas)

TABLE 3
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES - ADDITIONAL FACILITIES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
41) Glenville Town Landfill, Glenville New York (2)	D		• GW 15 to 20 ft below • Soils: sand and gravel of low permeability • 2 major water sources close to the site	• Poor operational procedures • Leachate flowing to an impoundment with no outlet • Leachate flowing through the site	• Shallow GW • Permeable soil • Lack of environmental controls • Poor operational controls procedures
42) Site A, Region VII (2)		D	• Located in floodplain • Leachate migrates toward SW	• Inadequate cover • No LCS	• Located in floodplain • Inadequate cover • No LCS
43) Shreveport Landfill, Shreveport, Louisiana (2)	D		• Located in 100-year floodplain • Surface runoff flows into the Red River - the major source of water • Underlain by highly permeable sandy soils • Shallow GW • GW used as potable water	• Solids: industrial and municipal codisposal • No GW monitoring wells • Past hazardous waste disposal • Lack of environmental controls	• Located in floodplain • Inadequate runon/runoff controls • Impact to SW • Permeable soil • Shallow GW • Lack of environmental controls • Past hazardous waste codisposal
44) Landfill and Resource Recovery, North Smithfield, Rhode Island (2)	D	D	• Underlain by glacial deposits above granitic bedrock overlain by stratified layers of sand silt • Depth to GW: 5-70 ft • Surface runoff discharges to a creek	• Accepted liquids and solids and some hazardous waste in the past (1977-1979) • Monitoring wells • No liner • No LCS	• Permeable soil • Shallow GW • No liners • No LCS • Paste hazardous waste disposal

TABLE 3
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES - ADDITIONAL FACILITIES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
45) City of Saratoga Springs Landfill, Saratoga Springs, New York (2)	D	D	• A stream's tributary bisects the site • The stream discharges into a lake used for sport and food fishing	• Poor operation procedures • No daily cover • Poor drainage system • Leachate ponds • GW monitoring wells	• No daily cover • Poor drainage system • Poor operation procedures
46) Orange County Sanitary Landfill, Town of Goshen, New York (2)	D		• Underlain by gravel and sand, underlain by up to 20 ft of heavy clay • GW depth: 25 ft • Adjacent to SW	• Solids and liquids codisposed • 3 GW monitoring wells • Runoff collection pond	• Shallow GW • Permeable soil • Inadequate environmental controls • Adjacent to SW
47) Fresh Kills Landfill, Staten Island, New York (2)	D	D	• Located in a "designated tidal wetland" • Red clay underneath • Leachate flows to the Arthur Kill that ultimately drains to the Raritan Bay	• Monitoring wells • Lack of other environmental controls	• Located in a wetland • Lack of environmental controls • Leachate flows into adjacent SW
48) Tantalo Landfill, Seneca Falls, New York (2)	D	S	• Located in a seasonal flood swamp • Located in a freshwater wetland • Seasonal depth to GW: less than 3 feet • Leachate flows off site • Drainage system discharges t[illegible] Wildlife Refuge	• Past hazardous waste disposal • Inadequate drainage system • Lack of environmental controls	• Located in a wetland • Shallow GW • Lack of environmental controls • Past hazardous waste disposal • Inadequate drainage system

TABLE 3
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES - ADDITIONAL FACILITIES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
49) Queensbury Landfill, Queensbury, New York (2)	D	D	• GW drains to Mud Pond	• Improper closure of a part of the site • No liner • Disposal of capacitors with PCBs (suspected) • Monitoring wells on site • No LCS	• No liner • No LCS • Inadequate cover • PCBs disposal (suspected)
50) Mayer Landfill, Pennsylvania (2)	D		• Located in rock quarry	• Received liquid waste • Site closed and covered • Poor operating procedures • Past hazardous waste disposal (illegally) • Disposal of wastes in an abandoned rock quarry	• Lack of environmental controls • Disposal in a rock quarry • Past hazardous waste disposal • Liquid waste disposal
51) Delmar Coward Landfill, Lower Burrell, Pennsylvania (2)	S	D	• High permeability soils • Depth to GW: 150 ft • Leachate discharges into SW	• Cover material are oils and shattered shale • Lack of environmental controls	• Permeable soil • Lack of environmental controls
52) Harrison Avenue Sanitary Landfill, Camden, New Jersey (2)	D	D	• Site is former wetland • Shallow GW • Leachate flows into the Delaware River	• No environmental controls	• Shallow GW • No environmental controls
53) Gloversville Landfill, Johnstown, New York (2)	D	S	• Underlain by sandy soils	• Municipal waste, tannery waste, sewage sludge and industrial waste • No LCS	• Permeable soil • No LCS • Industrial waste disposal

TABLE 3
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES - ADDITIONAL FACILITIES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
54) Johnstown Landfill, Town of Johnstown, New York (2)	D		• Underlain by a mixture of sand, clay and gravel of moderate permeability • GW spring on site • GW/SW hydrologic connection	• Accepted liquids • Accepted industrial waste until 1977 • Sand and gravel as a cover material • Final cover of sludge (30%) sand/gravel (70%) • GW monitoring wells	• Permeable soil • GW/SW hydrologic connection • Inadequate cover • Lack of environmental controls • Past hazardous waste disposal
55) Syosset Municipal Landfill, Syosset, New York (2)	D		• Located in the primary GW recharge area	• Received liquids and some industrial waste	LIAS
97) Jackson East Landfill, New Jersey (2)	D		• Soils: porous sands • Site is on the top of the Cohansey Aquifer - a sole source of drinking water	• No liners • Past chemical disposal • Past hazardous waste disposal	• Permeable soil • No liner • Past hazardous waste disposal
124) Torne Valley RDA, Town of Ramapo, New York (2)	D	D	• Leachate discharges to the Ramapo River - a potable water source	• Some industrial wastes (suspected to be illegally dumped) • Inadequate runon/runoff controls • On-site GW monitoring wells • Lack of environmental controls	• Inadequate runon/runoff controls • Lack of environmental controls • Industrial waste disposal

TABLE 3
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES - ADDITIONAL FACILITIES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
125) Merril Field Sanitary Landfill, Anchorage, Alaska ([illegible])	D		• Soils: sand and gravel underlain by fine gained lake deposits and compact, low permeability tills • 2 aquifers beneath (shallow and deep) • Leachate detected in the shallow GW	• Small amount of chemical wastes • 6 monitoring wells • Lack of environmental controls	• Shallow GW • Permeable soil • Lack of environmental controls • Past hazardous waste disposal
126) Denver-Arapaho Disposal Site, Aurora, Colorado (2)	D	S	• Soils: interbedded sands and clays and, in some areas, poorly sorted gravels	• Chemical wastes co-disposal before 1980 in unlined pits • Soil cover on the pits • Lack of environmental controls	• Permeable soil • Lack of environmental controls • Hazardous waste co-disposal
127) Lake Charles Landfill, Lake Charles, Louisiana (2)	S	D	• Moderate permeability of soils • Ponding	• Lack of environmental controls • Some industrial waste • Inadequate cover • Past hazardous waste disposal	• Permeable soil • Lack of environmental controls • Past hazardous waste disposal • Inadequate cover

TABLE 3
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES - ADDITIONAL FACILITIES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
128) Eastside Colby Landfill, Ponca City, Oklahoma (2)	D	S	• Located in a floodplain • Soils: sand and clay of permeability = 10-0.1 cm/sec • The depth to GW: 36 ft • The GW flows toward the Arkansas River • GW used for many purposes	• Solids and liquids codisposed • Monitoring wells • No LCS • No liners	• Located in floodplain • Permeable soils • No LCS • No liners
129) Crittenden County Landfill, Marion, Arkansas (2)	D		• GW 25-30 ft below • Located in a swampy area (wetlands) • Underlain by 95% sand and 5% clay of a very high permeability • GW is a source of potable water • Hydrologic connection of ground water and surface water	• Solids and liquids (industrial and municipal) waste • Inadequate cover • Inadequate drainage • Poor operation procedures • No liner • No LCS	• Permeable soil • Shallow GW • Hydrologic connection of GW and SW • No liner • No LCS • Inadequate cover • Located in swampy area (wetlands) • Inadequate drainage
130) Stark County/ Breitestine Landfill, Waynesburg, Ohio (2)	D	D	• Contaminated runoff discharges to SW	• Industrial waste accepted prior to November 1980 • Inadequate runoff control system • Inadequate cover (daily and final) • No LCS • No GW monitoring wells	• Inadequate runoff control system • No LCS • No GW monitoring wells • Inadequate cover

TABLE 3
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES - ADDITIONAL FACILITIES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
131) Saco Landfill, Saco, Maine (2)	D	D		• A variety of wastes received; including hazardous • GW monitoring wells • Site consists of municipal, industrial, and inactive (capped) landfill • Inadequate cover	• No liner at the old site • Inadequate cover • Past hazardous waste disposal
132) Old Ticonderoga Landfill, Ticonderoga, New York (2)	D	D	• GW ultimately drains into Lake Champlain	• Transformer oil (PCBs) accepted • Inadequate runoff/runon controls • No liners • No LCS	• No liner • No LCS • Inadequate runon/runoff controls • PCBs disposal
133) Glens Falls Landfill, Queensbury, New York (2)	D	D	• Soils: sand and gravel, highly permeable • Depth to GW: 20-40 ft • Leachate flows into adjacent SW	• Liquids, solids and capacitors with PCBs co-disposed • Inadequate final cover • No environmental controls	• Shallow GW • Permeable soil • Inadequate final cover • PCBs disposed • No environmental controls
134) Greenwich Landfill, Greenwich, New York (2)	D		• Waste disposed 5 ft above the GW table • Visible leachate ponding	• Paper mill sludge accepted among other wastes • Inadequate runon/runoff control system • Past hazardous waste disposal • Lack of environmental controls	• Shallow GW • Inadequate runon/ runoff control system • Lack of environmental controls • Past hazardous waste disposal

TABLE 3
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES - ADDITIONAL FACILITIES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
135) Colonie Sanitary Landfill, Town of Colune, New York (2)	D	D	• Leachate flows to the Mohawk River	• Hazardous waste disposal prior to 1980 • No GW monitoring system	LIAS
136) International Airport Road Sanitary Landfill, Anchorage, Alaska (2)	D		• Soils: sand and gravel underlain by fine grained lake deposits and compact, low-permeability till • 2 aquifers beneath (shallow and deep) • GW 4 to 18 ft below the surface • Leachate detected in the shallow aquifer	• Liquids and solids codisposed • 10 monitoring wells • Lack of environmental design controls	• Shallow GW • Lack of environmental controls • Past hazarqdous waste disposal
137) Colbert Landfill, Colbert, Washington (2)	D			• Sludges, solids and liquids codisposed • Lack of environmental controls	• Lack of environmental controls • Past hazardous waste disposal
138) Douglas County Sanitary Landfill, Gardnerville, Nevada (2)	D			• Solids and liquids codisposed (municipal sewage sludge and commercial waste)	• LIAS (lack of information to assess the situation)

TABLE 3
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES - ADDITIONAL FACILITIES (continued)

SITE NAME	DAMAGES		ENVIRONMENTAL SETTING	WASTE DESIGN AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
139) Hugo Waste Disposal Site Landfill, Hugo, Oklahoma (2)	D	D	● Underlain by sand and clay underlain by limestone ● Low permeability soil ● Perched water table at 1-2 ft ● GW less than 10 ft deep	● Solids and liquids codisposed (some industrial) ● Poor operation practices ● No liners ● Inadequate runoff control ystem	● Permeable soil ● Shallow GW ● Inadequate runoff control system ● Poor operational practices ● No liners
140) Bedford County Landfill, Shelbyville, Tennessee (2)	D			● Liquids and solids codisposed	● LIAS
141) Biggs Landfill, Memphis, Tennessee (2)		D	● Located in a floodplain ● Surface runoff and leachate flow directly into a creek	● Solids and liquids codisposed ● Inadequate runoff control system ● No liner ● No LCS	● Located in floodplain ● No liner ● No LCS ● Inadequate runoff control system ● Disposal of liquids
142) Oswald Landfill Long Swamp Twp, Pennsylvania (2)	D			● 7 monitoring wells on site ● Leachate pools ● Site is closed	LIAS
143) South Charleston Municipal Landfill, South Charleston, West Virginia (2)	D	D		● Some past hazardous waste disposal	LIAS
144) Bell Sanitary Landfill, Terry TWP, New Albany, Pennsylvania (2)	D	D		● Received liquids ● Site is an industrial landfill	LIAS

TABLE 3
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES - ADDITIONAL FACILITIES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
145) Kesselring Site Sanitary Landfill, Milton, New York (2)	D		• Adjacent to SW	• 3 GW monitoring wells	LIAS
146) Lone Pine Corp. SWDA, Freehold TWP, New Jersey (2)	D	S	• Soil: dense, quartz silty sand overlying a clayey glaucanitic sand • Adjacent to SW • Streams of leachate and leachate pools on site	• Solids and liquids were codisposed • Some chemicals and septic waste disposal • Sand used as cover material • No GW monitoring wells • No liner • No LCS	• Inadequate cover • No liner • No LCS • Past hazardous waste disposal
147) Niagara Sanitary Landfill, Tonawande, New York (2)	D	D	• 1,000 ft from the Niagara River • The depth to GW: 3-15.4 ft • Leachate flows through the site	• Some industrial waste disposal between 1968 and 1974 • Inadequate environmental controls	• Shallow GW • Past hazardous waste disposal • Inadequate environmental controls
148) Oswego Valley Sanitary Landfill, Volney TWP, New York (2)	D		• Underlain by a layer of sand and gravel 10-15 ft deep on top of the water table • Located close to an airport • Adjacent to SW	• Lack of environmental controls	• Permeable soil • Lack of environmental controls • Adjacent to SW
149) Wallkill Landfill, Bloomingburg, New York (2)	D	D	• Leachate flowing through the site and discharging to SW	• Solids, liquids, and sewage sludge codisposed	• LIAS

TABLE 3
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES - ADDITIONAL FACILITIES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
150) Waste Dispoal, Inc., Keyport, New Jersey (2)		D	• Located over an aquifer	• Accepted dilute printers ink (in addition to municipal waste)	• LIAS
151) Penaluna Landfill, Warwick, New York (2)	D			• Some past hazardous waste disposal (illegally)	• LIAS
152) Sanitary Landfill, Cranston Rhode Island (2)	D	D		• No liquids accepted • Pumpable sludges	• LIAS
153) Babylon Landfill, Babylon, New York (14)	D		• No surface water in the proximity of the site • Located on a highly permeable upper glacial aquifer 74 ft thick • Leachate discharges into the GW • The plume occupies entire thickness of aquifer		• Permeable soil
154) Hauppauge Landfill, New York (2)	D		• Located on a highly permeable upper glacial aquifer 170 ft thick • Leachate discharges to the GW • Hydrologic boundaries retard downward migration of the plume to deeper aquifers	• Lack of environmental controls	• Permeable soil • Leachate discharges to GW • Lack of environmental controls

TABLE 3
SUMMARY OF GROUND-WATER/SURFACE WATER DAMAGES - ADDITIONAL FACILITIES (continued)

SITE	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
155) Cheltingham Avenue Landfill, Schenectady, New York (2)		D	• Located on sandstone and shale of unknown permeability • Soils in area are of very high permeability • GW 30 ft below the surface • Leachate flows to adjacent SW	• No environmental controls	• Highly permeable soil • No environmental controls • Shallow GW
156) Bethpage Sanitary Landfill, Town of Oyster Bay, New York (2)	D	S		• Solids and liquids codisposal • Heavy metals and organics were co-disposed (stopped in 1979) • No environmental controls	• No environmental controls • Past hazardous waste disposal
157) Montgomery Co. Landfill, Amsterdam, New York (2)	D			• GW monitoring system on site	LIAS

TABLE 3
ARY OF GROUND-WATER/SURFACE WATER DAMAGES - ADDITIONAL FACILITIES (continued)

E	DAMAGES		ENVIRONMENTAL SETTING	WASTE, DESIGN AND OPERATION CHARACTERISTICS	LINKAGE
	GW	SW			
ttingham venue Landfill, chenectady, New York (2)		D	• Located on sandstone and shale of unknown permeability • Soils in area are of very high permeability • GW 30 ft below the surface • Leachate flows to adjacent SW	• No environmental controls	• Highly permeable soil • No environmental controls • Shallow GW
156) Bethpage Sanitary Landfill, Town of Oyster Bay, New York (2)	D	S		• Solids and liquids codisposal • Heavy metals and organics were co-disposed (stopped in 1979) • No environmental controls	• No environmental controls • Past hazardous waste disposal
157) Montgomery Co. Landfill, Amsterdam, New York (2)	D			• GW monitoring system on site	LIAS